2011 COV Report

1. General Findings

Firstly, the Committee wishes to express its sincere appreciation to the Geospace Sciences (GS) section members for their thoroughness and candor in support of the COV review. It is remarkable to see how much GS accomplishes with relatively modest funding levels and it is also clear that further strategic investments in GS programs would pay immense dividends. The COV is pleased to report that the GS section continues to be highly efficient and effective in carrying out its research and resource management functions. It is particularly gratifying to see how well GS has performed despite considerable federal budgetary uncertainty and turmoil in the recent past.

As a top-level assessment, the COV finds that GS has performed its stewardship of the aeronomy, magnetosphere, solar-terrestrial, and geospace facilities program with a high degree of efficiency and integrity. The processes and procedures employed in administering the programs have been fair, balanced, and highly transparent. The relevant review period (FY2008 – 2010) includes awards granted under the American Recovery and Reinvestment Act (ARRA). The COV finds ample evidence that both “regular” and ARRA award processes were carried out with the same high level of competence and effectiveness.

In our review of the programs, the COV saw repeated demonstrations of outstanding scientific accomplishments and noteworthy payoffs from Section funding decisions. As with any major enterprise, there can always be improvements. The COV offers here several suggestions on how to adjust the programs to make an outstanding effort even better. Our recommendations and findings are offered in this spirit.

2. Process of COV Review

COV reviews provide NSF with external expert judgments in two areas:

1. Assessments of the quality and integrity of program operations and program level technical and managerial matters pertaining to proposal decisions; and

2. Comments on how the results generated by awardees have contributed to the attainment of NSF’s mission and strategic goals.

The 2011 COV panel membership was:

Daniel N. Baker (Chair), University of Colorado at Boulder, AC/GEO Member

Nick Arge, Air Force Research Laboratory

Jorge Chau, Jicamarca Radio Observatory

Christina Cohen, Caltech

Anthea Coster, MIT

Joseph Huba, Naval Research Laboratory

Miguel Larsen, Clemson University

Terry Onsager, NOAA Space Weather Prediction Center

Larry Paxton, The Johns Hopkins University Applied Physics Laboratory

Joshua Semeter, Boston University

Michelle Thomsen, Los Alamos National Laboratory

The committee was provided with a set of specific questions on proposal processing and program management. As in prior COV reviews, answering these questions through investigations of proposal jackets and the compilation of statistics constituted the main activity of the visit. In the period before the meeting, committee members selected "jackets" from a list of proposals processed by GS in the period 2008 to 2010. The majority were selected by the COV members themselves, with a few additional ones of potential interest identified by the program directors. The jackets for the selected proposals were loaded into the Electronic COV module and were available for committee use prior to arrival at NSF Headquarters. Statistical information and a copy of the previous (2008) COV report were also provided prior to the meeting.

On the morning of the first day, the Committee was welcomed by GEO Assistant Director Tim Killeen. His brief remarks were followed by presentations by Section Head Richard Behnke and by Program Directors Therese Moretto, Kile Baker, Paul Bellaire, Farzad Kamalabadi, and Robert Robinson. These presentations provided valuable context and brought all COV members up to date on achievements and issues in the programs. The COV then spent significant time in breakout groups of two or three members to consider the four individual programs. The breakout groups generated answers to Parts A and B of the questions in templates provided by NSF. Each breakout group prepared a complete set of answers to the questions for the Chair to use in compiling the final report.

The whole COV contributed to the formulation of the list of collective findings and assisted the Chair in writing the overall conclusions in the present report. The COV was uniformly pleased with the support provided by GS staff for its work prior to and during the meeting. Efficient support was provided during the entire COV process by Program Director Therese Moretto. Requests for information were processed promptly, speeding the committee's work. The COV benefited greatly from the ease of access to data and materials through the Electronic COV software and database.

A preliminary verbal report was provided to AGS Division Director Dr. Michael Morgan and the GS staff at the end of the COV visit.

3. Summary of findings and recommendations

Our top findings and recommendations are as follows:

3.a Elevate GS to Division Level. The 2008 COV recommended that the Geospace Section be formed into a new Division within the Geosciences Directorate. This was also suggested by the NSWP Assessment Report (FCM-R24-2006): "The solar and solar-terrestrial program elements of the NSF should be managed as one, possibly division level, program so as to have a unified overview of both the basic research and space weather elements." The scope of GS is clearly much broader than just the upper atmosphere. The 2008 COV argued quite persuasively that with the creation of a new division several problems would be solved:

1. Improved synergism within Geosciences.

2. Improved synergism with the organization of the external solar and space physics community.

3. A better administrative home for solar physics in NSF.

4. Increased visibility of space science within NSF.

5. Improved interagency collaboration.

Since the 2008 review, several things have happened that further argue for establishment of a "Geospace Division". Notably, the Advanced Technology Solar Telescope (ATST) has been fully approved and is poised to begin full-fledged development in Hawaii. With this new start, the National Solar Observatory (NSO) will have new responsibility and will be relocated from its current locations in New Mexico and Arizona. The ATST will be a remarkable facility for solar and space weather research. It is ever more fitting that GS be the locus of management and operation of the ATST and its programmatic arms.

Another possible managerial opportunity relates to the Arecibo radio telescope facility in Puerto Rico. While Arecibo is presently managed within the NSF Astronomy division, future funding and utilization will be increasingly within the GS domain. Under such circumstances, the COV suggests that Arecibo (like ATST) be moved in an administrative sense into the Geospace arena.

With such increased responsibility and associated funding levels, clearly the GS portfolio would warrant "division" status. Yet another recommendation (see below) is that the highly successful CubeSat program presently run by GS should be funded with new NSF division-level resources. With increased resources, the CubeSat program would appropriately form its own "section". This would be a welcome component of the recommended Geospace Division as envisioned by our COV.

If, as we suggest, Geosciences is elevated to division status, it is crucially important that adequate funding resources be provided from the outset in setting up these managerial arrangements. In absolutely no way should any shifts of responsibility be undertaken unless full and fair funding is transferred to the new Division. Moreover, special care should be taken in future fiscal years to assure that resources remain adequate to the tasks at hand and that no harm is done to the outstanding core programs currently administered by GS.

<u>3.b Space Weather as a major "natural hazards" component of NSF.</u> As noted in the draft NSF document <u>Creating a More Disaster Resistant America</u> (CaMRA), "Mitigating natural and human-caused disasters requires a solid understanding of the science and engineering associated with these hazards, rapid integration of research results into disaster mitigation efforts, and efficient dissemination of information to decision makers in government and the private sector, as well as to the general public. High priority science and technology investments, coupled with sound decision making at all levels, will dramatically enhance community resilience and thus reduce the vulnerability of society to these events." The COV believes that space weather falls very much into the domain of CaMRA and should be actively included in NSF's natural hazard considerations.

<u>3.c Strategic Planning for GS</u>. The COV notes that especially in recent years, the Geospace Section has developed somewhat organically and has benefitted from opportunistic growth. This is to be applauded. However, in light of the above suggestions and in light of the likelihood of flat resource levels for some time to come, the COV strongly urges that GS engage in a more systematic strategic planning exercise. This planning should involve both "top-down" thinking from the GS staff as well as broad and thoughtful inputs from the community members. Together,

such a broad set of planning inputs would help refine the resource allocation and program balance in the new recommended Divisional structure.

3.d Fund CubeSats appropriately. The CubeSat program has brought a new excitement and potential for discovery to the GS program at NSF. There has been tremendous proposal pressure during the first few years of the program, indicating a strong interest in the program on the part of the community. The NSF program directors responsible for the program deserve credit for their leadership in this effort and for their vision in the development of the program.

The program now appears to be at a critical juncture, and we encourage the program directors to consider the following points:

1) The large number of CubeSat proposals that were submitted for the last two competitions form the basis for a program that can have a long and successful history, but the low acceptance rate, limited by the relatively small available budget, may quickly lead to a diminshed enthusiasm in the community.

2) The expectation when the CubeSat program was initiated was that GS program funds would be used in the start-up phase but that other funds would be brought into the program as its initial success became established. We are now several years into the program with no significant additional funds for the program.

Both points suggest that the program needs to be adequately funded to maintain a reasonable acceptance rate (encouraging a high level of creative proposals) and to reduce the pressure on the current GS budget.

Another issue considered by the committee is the perceived goal of the program. The submitted proposals have presented a broad range of innovative approaches to miniaturizing instruments and for new measurement strategies that can be adapted to the small CubeSat form factor. The educational value for students working on CubeSat projects seems clear, but the potential scientific value of the missions is still not completely clear.

The program directors are encouraged to clarify the objectives of the program. Is it primarily an educational program? If so, can similar objectives be achieved with other much less expensive options, such as student rocket launch projects, for example. Is the objective primarily to obtain new science results? If so, what niche is the program specifically filling? Is the science yield that can be expected competitive with the science yield from more conventional GS instrumentation with similar costs?

The point here is not to criticize the program or discourage its continuation, but to encourage a clearer articulation of its objectives and its role as part of the instrument portfolio of the division.

3.e FDSS. The COV considers the Faculty Development in Space Sciences program a very important initiative in GS. It grew out of the recommendations of the NRC Decadal Study for Solar and Space Physics (NRC 2003). While it remains a bit early to judge fully the success of this program, the present results are indeed promising. All available positions were filled with talented young scientists and they are progressing well toward tenure. Two have already been granted tenure. Some are starting to take leadership positions in the CEDAR, GEM and

SHINE communities. The COV strongly recommends the continuation of the FDSS program in a staggered manner at the discretion of UARS. The FDSS program is critical for the future health of the space science community..

3.f Interdisciplinary research. The 2008 COV took note of the increasing importance of science at the interface between traditional disciplines and encouraged the program directors to continue to inform and educate the community about inter- and multi-disciplinary funding opportunities offered by agency-wide programs. They have done so, but there remains concern that the traditional discipline-based structure of the section (AER, STR, MAG) may inhibit cross-disciplinary research efforts. The COV encourages the program directors to continue to work together to identify innovative ways to enable more research into the coupling and system aspects of the solar-terrestrial system.

3.g Virtual vs. face-to-face panels. The panel discussed a number of pros and cons regarding virtual and face-to-face panels. Virtual panels have the advantages of convenience for panelists, enabling some to participate who would otherwise be unable to do so, and low cost for NSF. However, there are disadvantages that Program Officers should be aware of and which they must do their best to compensate for. The discussions that occur during panel deliberations are sometimes contentious, yet are necessary to uncover the various issues underlying the scientific merit of the research. Face-to-face panels give the panelists the opportunity to meet each other, to gauge the reactions during constructive exchanges by observing body language, and to have side discussions as needed during breaks and meals. Virtual panel discussions are lacking in these “cultural” aspects, especially when the panelists do not already know each other. Moreover, face-to-face panels also give the opportunity for young members of the community to interact professionally with a diverse group of peers, which can lead to future opportunities and career building.

Three recommendations are offered regarding panels. First, a balance of virtual and face-to-face panels should be maintained. Particularly when the level of funding is high and the issues potentially controversial, a face-to-face panel is preferred. For the more routine assessment of standard programs, virtual panels may be adequate. Second, the Program Officer should be aware of the potential difficulties in communication that can occur during virtual panels and strive to ameliorate them. The Program Office will need to be diligent in noting issues that may not be pursued in sufficient detail during the discussion, and either encourage additional discussion during the panel or have follow-up discussions with the panelists offline. And third, when using virtual panels, explore the use of the most up to date video conferencing capabilities rather than relying on audio only, for example.

3.h College of reviewers. The previous COV suggested a “college of reviewers” as a possible mechanism for recognizing the status and acknowledging the value of those persons contributing to the review process. The current COV believes it is clear that this would greatly help NSF, and perhaps also be a model that is (begrudgingly) beneficial to reviewers (e.g., reviewers sign up to do 6 reviews in one year, then get 5 years off). On the other hand, some proposals should be reviewed with an eye toward a particular expertise that may not be captured by the “college”, and so exceptions should be allowed.

3.i Additional Program Directors/Support staff. If, as it appears, the number of proposals submitted to GS is going up, but the number of awards is staying the same, then the burden on the NSF staff is increasing, not only because more reviews are needed, but because rejections, which are more time-consuming, are required in ever greater numbers.. Thus, additional staff assistance is needed, which could be provided by additional rotator positions. However, the COV notes that successful scientists will likely not wish to put their entire research program on hold to come to NSF temporarily, so rotators should be granted a sufficient percentage of their time to continue research programs. This could be accomplished by dividing rotator position into two, 20-hours each, and allowing them to continue receiving funding (even if from NSF). Other possible staff augmentation solutions include hiring more contractors and, perhaps, lower-level administrators.

3.j Education programs/summer schools . The Geospace Section has sponsored a large number of programs involving education. Among these include the CEDAR, GEM, and SHINE workshops, which enable students to connect and interact with faculty and researchers and to be exposed to current research in their respective areas. There are a number of Research Experience for Undergraduates (REU) and Research for Teachers (RET) programs sponsored by the Section. Over the past 10 years, there have been a number of education-oriented specialized workshops, including the Center for Integrated Space Modeling (CISM) school, the Polar Aeronomy and Radio Science (PARS) school, and the Advanced Modular Incoherent Scatter Radar (AMISR) student workshop. In general, these specialized schools have been highly successful and appear to be meeting a need within the community not being met elsewhere. The CISM summer school has been associated with the CISM program, which is soon coming to an end. The future of the PARS school is unclear. The AMISR student workshop, which is run out of the Geospace Facilities program, is in its fourth year and has been growing for the past three years. It is recommended that these schools be maintained and operated in the future. Perhaps some opportunity for running these (or different) schools should be competed, in order to allow for their proper evaluation and continued growth. This is a special concern for the CISM program, which is about to end.

3.k International aspects of programs. It is recommended that GS take a lead role in developing opportunities with international partners. There is expanding international interest in and rapid development of geoscience activities, involving instrumentation, modeling, education, and interdisciplinary research. Furthermore, there is a strong desire among numerous countries to partner with the U.S. in these areas. As examples, the European Union is eager to coordinate funding within its Framework Program with U.S funding opportunities, the European Union Research Infrastructure Program is interested in coordinating its EISCAT-3D program with NSF-supported incoherent scatter radar facilities, China's Meridian Program for ground-based instrumentation provides assets that would be highly valuable for U.S. geosciences, South Korea is a participant on one of the CubeSats, and the United Kingdom recently formed an interagency committee on space weather, forming a UK alliance similar to the U.S. National Space Weather Program. The activities occurring around the globe present valuable opportunities for NSF to leverage the investments and accomplishments of our foreign partners. GS should actively establish partnerships and support complementary research and infrastructure development that will serve to integrate research, education, and infrastructure programs in other countries with those supported by NSF to the benefit of U.S. scientific development and improved international relations.

3.l Standing science advisory groups/Visitor program Discussions with the program directors during the COV meetings indicated that they would like and have a need for better and more focused advice about problems and research opportunities in the field. Some of the relevant information is obtained by attending professional meetings and talks and some information is obtained in informal interactions with community members, but it seems clear that an advisory committee could provide critical information to the NSF staff in a more focused way. An appropriately constituted committee can be a valuable resource to the program directors as they assess and guide future developments in the various research areas that they manage. A related suggestion is to develop a visitor program in which individuals or small groups can be invited to visit NSF and provide more extensive briefings to the staff on critical science topics.

3.m ARRA funds/usage. The COV notes that the ARRA funds were used to support excellent scientific efforts and allowed the GS to expand their funding of more new PI-led and CAREER proposals. However, even with the additional ARRA funds, there were many high quality proposals that were not funded. This underscores the fact that the GS budget is insufficient to support all the submitted proposals deserving of funding.

4. Additional Findings

4.a Satellite data. Investigations involving coordinated measurements from ground and from space have been conducted in an opportunistic fashion in years past. THEMIS showed the scientific efficacy of designing such coordination into a major mission. This potential should be further exploited through increased NASA-NSF-DoD collaboration.

4.b Student pipeline The students at CEDAR, GEM, and SHINE meetings come from a diversity of backgrounds (engineering, physics, astronomy, etc) and go on to a diversity of careers. This model is a win-win: The meetings are well attended and have vitality (good for AGS) and yet seem not to produce an overload of people seeking a career in the disciplines (also good for AGS). Overall, the Committee strongly endorses NSF's efforts to bring in and nurture promising young new talent in the space sciences community. However, with today's flat budgets, NSF should be mindful of the delicate balance required to maintain stability in the system. Too much bias in the funding of young new scientists over that of more experienced and seasoned researchers can have its own negative impact by producing more scientists (even those exceptionally talented) than the system can reasonably support.

4.c Facilities lifecycle. It is clear that some of the Geospace facilities are able to evolve and meet the needs of the field as they develop. However, it is not clear that this is true of all the facilities in the portfolio. We encourage the program directors to develop criteria and a strategic plan for the short-term and longer-term future of the various facilities and their role in the achieving the overarching goals of the program.

4.d Data access/data advisory panel. The 2008 COV raised issues about data access and data policies. While the present Committee shares these concerns, we learned that these issues are being dealt with at higher levels in NSF. We look forward to seeing great progress on these issues in the next several years.

4.e More emphasis on "prior performance". Results from prior work should be a baseline criterion for proposal selection. There appears to be some leniency on award selection for investigators who have been funded continuously for many years on a particular topic or facility.

4.f Postdoc U.S. only: Good or bad? While the new way of awarding postdoc funding does have some advantages in terms of portability and perhaps prestige, the elimination of foreign national candidates is a serious diminishment of the talent pool. On the other hand, the postdoc positions filled through the regular grant process would still be available for foreign nationals, so maybe the loss is not as severe as the COV initially feared. We urge the community and the NSF staff to keep a close eye on any deleterious effects of this change.

4.g Rising facility costs/Flat funding. NSF admits that flat funding has been used as a wedge to obtain partial resources for other efforts (e.g., CubeSats). It is not clear why facility costs should be rising, unless we are talking about one-time maintenance costs. AMISR facilities, for instance, have small (1/2?) operating budgets compared to older facilities (they can be run remotely, they don't have klystrons). Facilities could reduce science staff funding, and focus on community support.

Facility costs include several factors that may increase at a rate higher than the general rate of inflation. There are three factors that may contribute to a change in the balance of funds allocated to science vs. those allocated to "operations". Energy costs are rising at a rate much faster than inflation. Polar facilities are particularly sensitive to the cost of energy due to the use of diesel-fueled generators. Wage costs may also increase at a rate faster than inflation, particularly for those facilities that rely on staff and services fulfilled at non-US locations such as the SuperDARN radars and the Jicamarca facility. The third factor is that as facilities age, maintenance becomes increasingly costly.

The growth of facility costs at a rate higher than inflation, especially in a time of fixed budgets, represents a challenge to maintaining the scientific productivity of the facility. With fixed resources the growth of facility costs implies a decrease in resources applied to science. This pressure on the science budget may lead to the need to balance science achieved with total cost and to assess whether or when a facility should be upgraded. The reach of an upgrade, that is to say the power of an upgrade to enable new or transformative science, may be limited by the location of the facility or some other factor. In that case, the decision to upgrade or maintain needs to be weighed against the discipline's strategic science plan.

While facilities can be upgraded, there is an important distinction that should be made between the physical facility and the staff associated with that facility. The costs need to be maintained separately so that a realistic appraisal of the benefits of continuing to operate the physical plant compared to maintaining the science staff can be achieved. From the review of the facility proposals it was often difficult to distinguish between the costs of maintaining and operating the facility and the costs of maintaining the staff whose functions are largely research oriented. This distinction needs to be made clear so that informed decision can be made about the cost/benefit of the facility vs. the staff as the technologies behind a facility "age out". It may well be that a facility that was originally associated with a particular piece of equipment undergoes a transformation with time as the need for that particular piece of equipment decreases. This transformation process needs to be managed against a strategic plan.

The COV suggests that efforts be made to assure that the staff at the incoherent scatter radar (ISR) facilities maintain expertise in plasma physics, ionospheric physics, and the processes associated with ISR facilities. The ISRs are the cornerstones of the Geospace Facilities program and require adequate technical support to maintain the functioning of the instruments and to advance the technology development at the facilities. The shift in research focus within these research area toward less traditional ionospheric physics, such as neutral atmosphere dynamics and large-scale modeling, raises concerns about the future.

Submitted on Behalf of the Committee of Visitors,

Daniel N. Baker

Daniel N. Baker

Chair, COV

Attached: Breakout group reports (AER, MAG, STR, GF)

FY 2011 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: 5/4/2011 – 5/6/2011
Program/Cluster/Section: Aeronomy
Division: Atmospheric and Geospace Sciences
Directorate: Geospace Science Section
Number of actions reviewed: Awards: Declinations: Other: (39/21/18)
Total number of actions within Program/Cluster/Division during period under review: Awards: Declinations: Other: out of a total of 332 combined (2008-2010)
Manner in which reviewed actions were selected: **individually chosen to cover a broad mix of actions.**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments:	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: As indicated in previous COV reports, the broader impacts criteria are harder to address. However, we noted that some areas are now standard in most of the proposals and review analysis: students, space weather, outreach activities.	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: Depends on the reviewer; typically more information is provided if the review is negative. One possible improvement in the reviewing process is to ask the reviewers to consider past performance on prior NSF awards as a significant criterion in evaluating proposals.	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel review does not always match the individual reviewers recommendation and although they attempt to address this, in certain cases where the individual reviews were very positive, the panel's explanation for not ranking it as highly as the write-in reviews was not substantiated. There were also some cases with both positive and negative reviews, and the panel tried to reach a consensus. For example, in one award, one of the deciding factors given by NSF for granting this award was the broader impacts of this proposal which included a female graduate student.	Not always

5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: In most cases, the answer is yes. In some cases, proposals which were highly rated were turned down and the rationale for their ranking was questionable. This may simply have been an issue of limited funding resources. The aeronomy break-out group views it as a plus that the NSF program manager does not necessarily rubber-stamp the panel or reviewers recommendations. This is evidenced by the action on 0737625 (Zabotin).	Yes (qualified)

6. Does the documentation to PI provide the rationale for the award/decline decision? Comment: In general, this is excellent.	Yes

7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: In 2010, the time of action on a proposal has increased and the std. deviation has also increased. but the average response is less than 6 mos. for more than 50% of the proposals in all three years. However, to the credit of the aeronomy program, they are overseeing a larger number of proposals than the other programs. Also, as compared to the previous evaluation, we see that the dwell time has improved and is getting closer to the NSF goal of 70%.	No
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? Overall, the merit review process is handled in an excellent manner by the NSF aeronomy section. For the core program, the program officer(s) seems to manage to effectively balance the reviews and the other constraints they are working with: funding issues, program balance, distribution of funds. Based on the information provided in the jacket, ARRA funding was also handled in an excellent manner (see comments below related to ARRA proposals).	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: In general, the answer is yes. There were two cases the aeronomy break-out group thought that a computational physicist or modeler should have been one of the reviewers. There should be at least one reviewer who is an expert in the subject matter of every proposal evaluated (to the extent that this is possible).	yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: From statistics provided, the numbers reported represent the general balance in the outside community.	yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Yes, we saw a couple of examples where conflicting reviews were removed from consideration.	yes
4. Additional comments on reviewer selection:	

[2] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Overall, the research supported under the aeronomy program is of high quality and is a credit to NSF. There are a very few exceptions to this.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: They are promoting educational projects. We were somewhat surprised to learn that the distribution of funds was 30% non-educational institutions/70% educational institutions. The CEDAR workshop and the REU program are positive. In the aeronomy budget, currently 20% is going to senior personnel and 12% graduate students.	Appropriate

[3] If "Not Appropriate" please explain why in the "Comments" section.

3. Are awards appropriate in size and duration for the scope of the projects? Comments: Given the funding available, the size and duration seem to be adequate.	Appropriate
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: A truly innovative research program at the Catholic University was funded by ARRA in the Space Weather Program. The proposal was the highest ranked by the review panel; in fact, it was the only highly recommended proposal out of roughly a dozen submissions. Additionally, very strong proposals were funded by ARRA, as well as an REU program at the University of Michigan. This demonstrates an excellent use of ARRA funds by the aeronomy section.	Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter-and Multi-disciplinary projects? Comments: This is appropriate and improving. We know that this is an area that is being worked out (Frontiers, connections with GEM and the lower atmosphere). Currently they co-fund solar, lower atmosphere, physical and dynamical meteorology, and magnetosphere.	Appropriate

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments:	Appropriate
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: In the aeronomy section 30 – 40% of the awards are to new investigators and the remainder to past investigators. This demonstrates that NSF is actively supporting new (and younger) scientists. This applies to ARRA funded programs: the section funded 5 CEDAR postdocs with ARRA funds.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The geographical distribution is as even as the field itself.	Appropriate

9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: Most research money goes to research intensive universities (~60%), followed by business.(~24%). The rest of the money goes to other types of non-PhD universities and colleges. This appears appropriate.	Appropriate
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: In general, a broad spectrum of research topics is represented in the aeronomy proposals funded. This includes coupling of the ionosphere and thermosphere to both the lower atmosphere and the magnetosphere, meteor and lightning physics, MLT dynamics, ionospheric electrodynamics, space weather, etc. Furthermore the section supports integrated theory, modeling, and observational programs to achieve an understanding of fundamental aeronomic processes.	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The section funds 15 female PIs and 12 minority PIs out of 97 funded programs. Additionally, funding is going to younger females, to minority institutions, and to minority faculty members. This is an area that is being proactively addressed by the aeronomy section.	Appropriate
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: Space weather research programs have been funded which are of national priority and can be included in the 'natural hazard' category. Some research is also related to climate change.	Appropriate
13. Additional comments on the quality of the projects or the balance of the portfolio: Comments: ARRA funding is also addressed in the COV summary.	

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: Aeronomy program managers have all been of the highest quality and have approached their job with integrity. To provide continuity of the program it is strongly recommended that there be an overlap of program managers during the transition period when the current director rotates from the position.
2. Responsiveness of the program to emerging research and education opportunities. Comments: As noted earlier, the section funded a highly innovative research program under the auspices of the Space Weather Program at the Catholic University of America. Additionally, the section has vigorously supported young faculty through Career awards. Three Career awards that were highly successful have just ended, and three awards were made during the current evaluation period. This clearly demonstrates that the section supports emerging research and education opportunities.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: We have not identified a formal planning or prioritization process. The CEDAR steering committee will soon release a new strategic planning document that should be taken into consideration when developing future funding priorities for the aeronomy program.
4. Responsiveness of program to previous COV comments and recommendations. Comments: Without a strategic plan it has been difficult to implement recommendations from the previous COV. In general, given the circumstances, the program is being well-managed.

PART B. RESULTS OF NSF INVESTMENTS

. The NSF mission is
to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

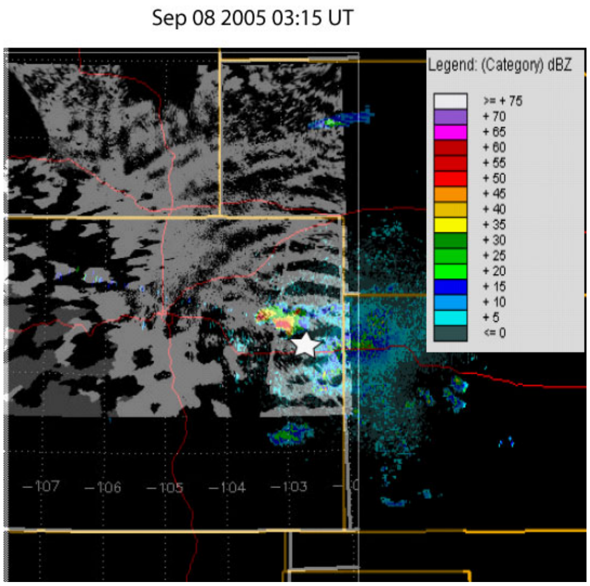
B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

The aeronomy section strongly promotes research that significantly benefits the scientific community and national needs. This is illustrated by a number of the selected highlights given below (PI: She, Hysell, Kelley, Hickey, Bilitza, Fuller-Rowell, Foster, Collins, Kudeki).

Coupling of the lower and upper atmosphere

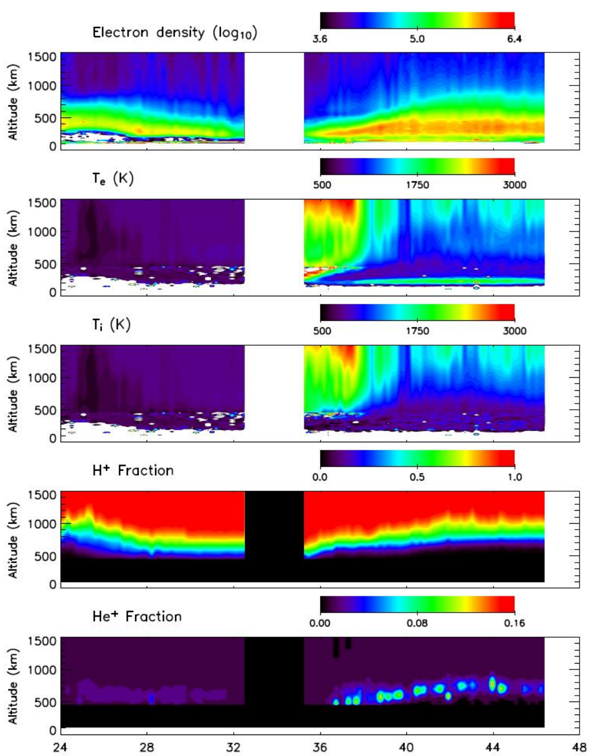
Chiao-Yao She, Matthew McHarg, Hans Nielsen (0335127, 0545221, 0535476)



Using an all-sky imager located at Yucca Ridge, Colorado researchers observed a rare signature of a convectively generated gravity wave at a height of 87 km. Like ripples produced by a stone that strikes a pond, the gravity waves from the thunderstorm radiate outward from the source but they also propagate upward. The figure shows an observed gravity wave pattern (with the epicenter marked by a star) overlaid on a NEXRAD radar image of the associated thunderstorm in the troposphere separated by ~30 min, the time it takes the wave to propagate from 15 to 87 km altitude. These observations demonstrate the transient, direct coupling of energy from the troposphere to the mesosphere and lower thermosphere region, lasting on the order of several hours.

Comprehensive Measurements of the Equatorial Ionosphere

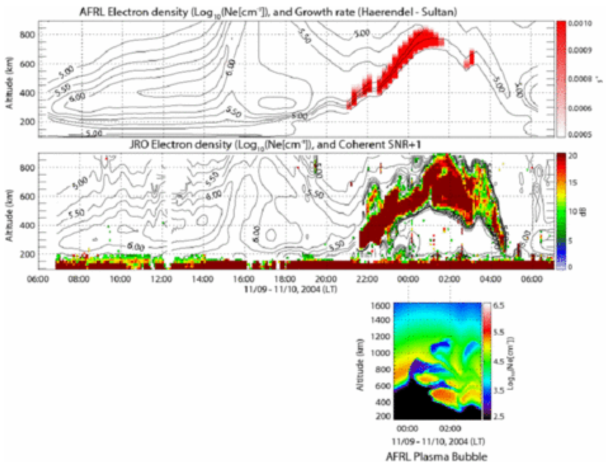
Hysell (0432565)



A new technique implemented at the Jicamarca Radio Observatory allows unprecedented measurements of the height profile of properties of the ionosphere and thermosphere. Until now, the incoherent scatter radar technique has not been used at the equator because of ionospheric irregularities that swamp the weak signals from incoherent scattering. The new technique uses a combination long-pulse and double-pulse transmission and the return signals are analyzed using a full-profile analysis. With this technique, height profiles of plasma density, electron and ion temperatures, and light ion composition profiles in the topside are estimated simultaneously. Full-profile analysis is crucial at Jicamarca, since the properties of the ionospheric plasma prevent conventional range-by-range analysis. The analysis provides the first comprehensive assessment of ionospheric conditions over Jicamarca at sunrise as well as the first comprehensive record of helium ion layers.

Predicting Space Weather

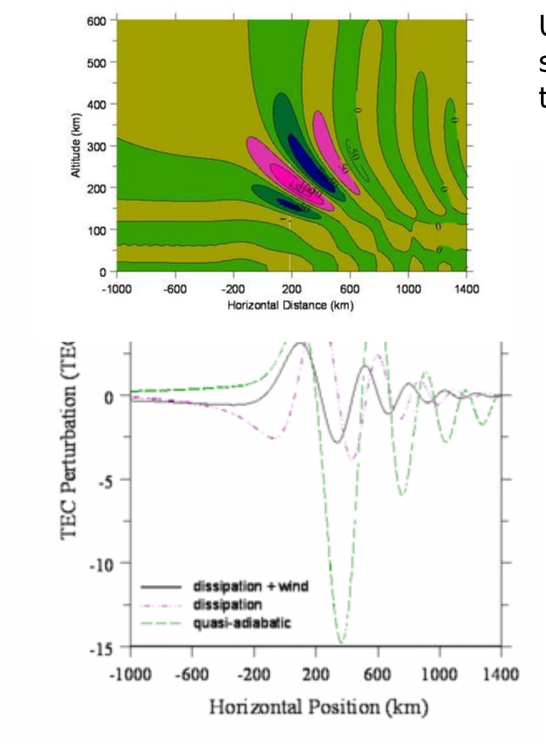
Kelley (0551107)



One of the major challenges of the National Space Weather Program in the United States is to predict the generation of intense turbulence in the equatorial and low latitude ionosphere. One type of these turbulent events has been termed a Convective Equatorial Ionospheric Storm since, much like a thunderstorm, low density media erupt upward, releasing stored gravitational energy. This is an important phenomenon since both communication and navigational systems can be severely affected by the associated turbulence. Professor Michael Kelley and collaborator James Retterer of the Air Force Research Laboratory used solar wind data obtained upstream of the Earth to predict the electric field at Jicamarca Radio Observatory, an NSF facility in Peru. This was input into the Air Force's physics-based assimilative model, which successfully predicted an event observed during a strong magnetic storm in November 2004. Measurements (middle panel) and predictions (upper panel) of the electron density and the development of turbulence at the magnetic equator. The red area in the upper panel shows the predicted growth rate for instabilities. The colors in the middle panel indicate the strength of the turbulence, with red indicating strong turbulence. The small color plot in the bottom panel shows detailed predictions from the model during the storm period. Note that the model predicts low-density bubbles extending to altitudes greater than 1000 km during the storm.

Waves caused by tsunamis can affect the upper atmosphere

Hickey (0408407, 0639293)



Using a numerical model, three researchers were able to show that tsunamis can generate waves in the atmosphere that reach hundreds of miles in altitude.

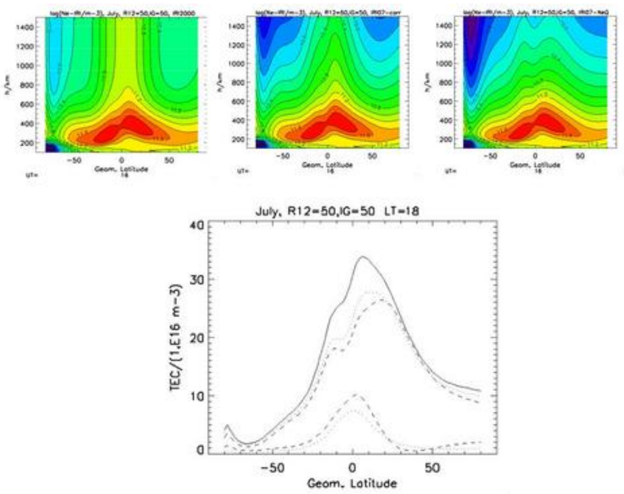
Michael Hickey of Embry-Riddle Aeronautical University, collaborating with Richard Walterscheid and Gerald Schubert, used a numerical spectral full-wave model to simulate the excitation of an atmospheric gravity wave packet by a large tsunami similar to the Sumatra event of December 26, 2004. In the model, the tsunami generated a 200 m/s disturbance that propagated upwards hundreds of miles where it eventually dissipated (Figure 1). The tsunami also caused disturbances to the ionosphere in the model, as shown in Figure 2 which plots the large perturbations in the total electron content of the atmosphere (Figure 2).

These simulations of the atmospheric response to a tsunami-like disturbance are the most realistic to date. Model results like these, combined with ionospheric observations such as from GPS, may prove to be a viable way to measure and predict landfall of tsunamis while they are still far out to sea and difficult to measure. Such combinations of measurement and modeling predictions would complement other methods currently in use. If the approach is feasible, there could be tremendous practical applications to saving human lives through earlier warning, especially in underdeveloped countries.

Figure 1. Horizontal velocity perturbations in the model caused by a tsunami at the model lower boundary. The maximum wind perturbation is ~ 100 m/s near 300 km altitude.
Figure 2. Fluctuations in Total Electron Content (TEC) caused by tsunami-driven waves propagating northward. The different curves show the perturbations caused by using different assumptions in the model.

MULTI-RESOLUTION IONOSPHERE MODELING: INVESTIGATING STRUCTURE OF EQUATORIAL ANOMALY

Bilitza, Shum (0417666, 0418844)



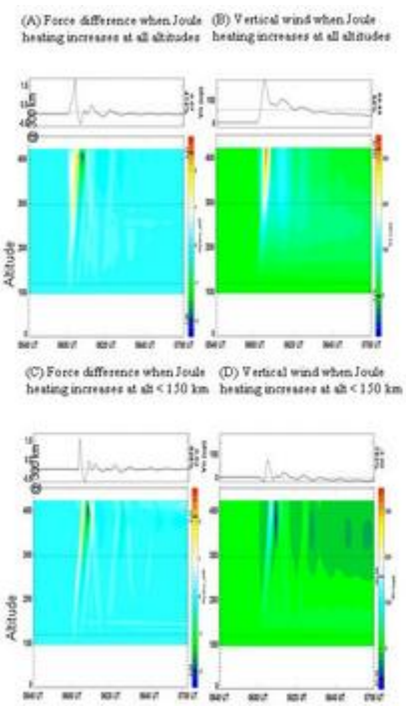
Dr. Dieter Bilitza of George Mason University, Dr. C.K. Shum of Ohio State University and a team of national and international collaborators have developed new models for the representation of the topside electron density in the International Reference Ionosphere (IRI). IRI is the international standard for the specification of ionospheric densities, temperatures and velocities as recognized by the International Standardization Organization (ISO) and the European Cooperation on Space Standardization (ECCS). The team re-analyzed topside sounder data from the sixties, seventies, and eighties, the prime data source for studying the global morphology of topside electron density and developed new models that improve the densities up to a factor of two over the older model. The older IRI model overestimated the total electron content (TEC), a parameter that is very important for many space weather applications. At the magnetic equator, where TEC values are the largest, the new models achieve a 30% improvement. Another important feature to represent accurately is the density structure of the low latitude ionosphere which exhibits an "Equatorial Anomaly", with lowest daytime densities at the equator and larger densities appearing in two crests to either side of the equator. Simulations with the new models show that the characteristic anomaly features are much better represented by the new topside models.

Top: Plots of the logarithm of electron density as a function of latitude and height, for longitude 0 degrees, 1600 LT, and medium solar activity. The left panel shows the old IRI model predictions, the middle panel, the new model, option 1; the right panel, the new model, option 2. The middle panel is the best representation of the Equatorial Anomaly.

Bottom: Total Electron Content (TEC) versus geomagnetic latitude at Local Time (LT) = 18:00, medium solar activity in summer for the different models: IRI-old (solid line), IRI-new-option1 (dashed line), IRI-new-option2 (dotted line). Also shown at the bottom are the difference curves IRI-old - IRI-new-option1 (dotted line) and IRI-old - IRI-new-option2 (dashed line). Note the significant decrease in TEC at the magnetic equator when using the newer models

Modeling vertical winds in the upper atmosphere

Fuller-Rowell (0823689)



The non-hydrostatic effect on the thermosphere has been quantified using a general circulation model (GCM). Hydrostatic equilibrium is one common assumption used in most theoretical thermosphere/ionosphere models, under which the pressure gradient force is balanced by the gravity force in the vertical direction. This assumption represents the large-scale atmosphere behavior very well, but on small spatial scales and during short time periods the non-hydrostatic processes can cause large vertical winds and strong disturbances of neutral density in the upper atmosphere. The preliminary results show that after a sudden enhancement of Joule heating, the force imbalance between the pressure gradient and gravity forces at high altitudes can be as large as 25% of the gravity force and is mainly caused by the vertical propagated disturbance. The large vertical wind at high altitudes is a superposition of in-situ thermo-expansion and a propagated wind disturbance from the lower altitudes, which adds a strong temporal variation. The evaluation of the non-hydrostatic effect on the upper atmosphere is of primary importance in properly modeling the global thermospheric/ionospheric system. This NSF-funded research is a necessary step in improving the ability to simulate the thermosphere/ionosphere response to magnetospheric energy input.

Figs. (A) Temporal variation of the difference between the pressure gradient and gravity forces after a sudden enhancement of Joule heating at all altitude at 0600 UT. (B) Temporal variation of the vertical wind after a sudden enhancement of Joule heating at all altitude at 0600 UT. (C) & (D) Same as (A) & (B) except only including Joule heating increase below 150 km altitude.

Investigations of the role of the ionosphere in sudden warmings in the Stratosphere
John Foster (0733510)

Highlight ID: 19148, Version: AC/GPA

Researchers have previously proposed that lower atmospheric processes may account for some ionospheric variability. With this in mind Goncharenko and colleagues from MIT Haystack Observatory and Jicamarca Radio Observatory studied an episode of sudden stratospheric warming, which occurred in January 2008, and compared results with temperature fluctuations in the ionosphere and thermosphere as recorded by a ground-based radar. Goncharenko found that at middle latitudes, ionospheric variations that could not be explained through the seasonal trends, solar flux, and geomagnetic activity, and were instead correlated with fluctuating temperatures in the stratosphere, demonstrating a previously unobserved link between the lower atmosphere and the ionosphere. As sudden stratospheric warmings are a high-latitude event, the most unexpected changes observed during this warming episode were large semidiurnal variations in low-latitude plasma velocities, with upward plasma transport in the morning hours, followed by the downward transport in the afternoon hours. The electron density data from ground based GPS receivers revealed an enhancement of equatorial ionization anomaly in the morning and suppression in the late afternoon, as a result of this plasma motion. The observed control of the daytime equatorial anomaly has major practical space weather implications. These results have demonstrated that studies of space weather should consider ionospheric variability linked to stratospheric changes.

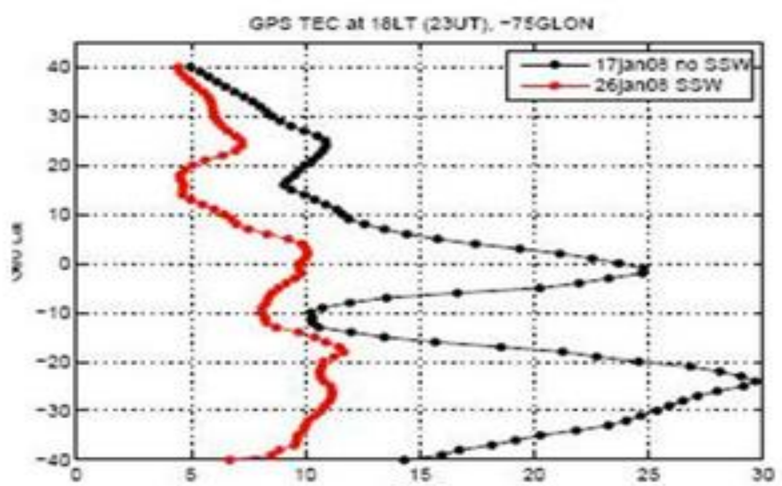


Figure (1)

Figure (1). Variation in mid-latitude ion temperature observed during stratospheric warming as compared to baseline data. A warming is observed in the lower thermosphere at ~120-140 km, accompanied by a 20-75K cooling above ~140 km. It is well established that stratospheric warming is accompanied by mesospheric cooling, but these observations show for the first time that areas of warming and cooling extend to altitudes of upper thermosphere (~300 km).
Credit: Larisa P Goncharenko
Permission Granted

Multi-Instrument Measurements of Polar Mesospheric Clouds

Collins, Heinselman, Thayer (0514103, 0608577, 0454999)

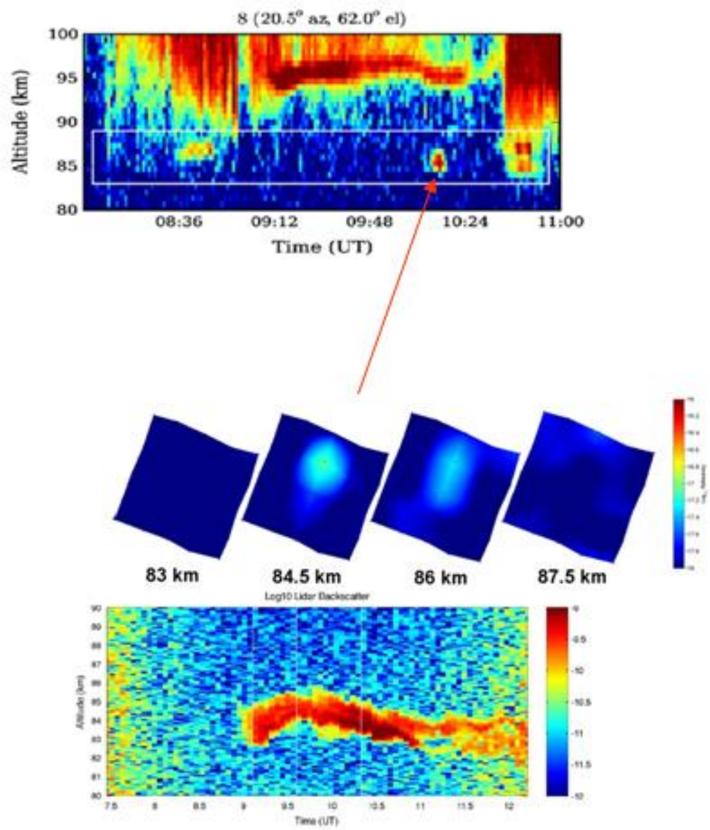


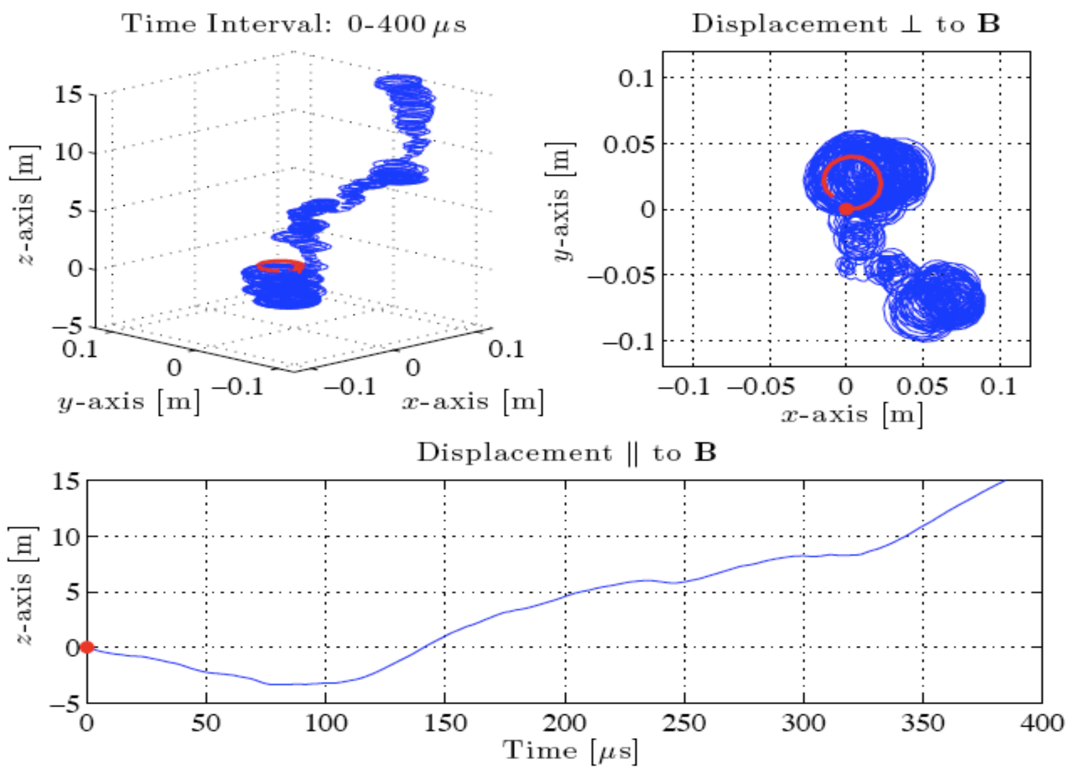
Figure (1) First comparison of 2-D structure in NLC and a height localized PMSE structure within the PFISR field of view.
Credit: Mike Taylor
Permission Granted

Novel coincident radar, lidar and imaging measurements of dynamical structures in Polar Mesosphere Summer Echoes (PMSE) and Noctilucent Clouds (NLC) were made on 10-11 August, 2007 in coordination with the NASA AIM satellite. Common volume mesospheric data were obtained over central Alaska using the new NSF funded Poker Flat Incoherent Scatter Radar (PFISR), combined with measurements from a co-located Rayleigh lidar and digital imaging from two nearby ground stations. The coincident measurements enabled the first detailed investigation of the horizontal and vertical structures of NLC and PMSE. On this particular study day, a well developed NLC was measured within the radar volume from ~9:00 UT until dawn. Strong but intermittent PMSE were detected by the PFISR instrument, with distinct patchy structures that exhibited a similar southward motion as the NLC; see Figure(1). Detailed comparison of the 3-D PMSE structures and the NLC lidar and 2-D image data have revealed striking similarities when account is taken of the NLC layer altitude. Later measurements indicated that strong wind shears associated with Kelvin-Helmholtz instabilities (NLC billows) played a key role in the development of a neutral turbulence layer that resulted in the intermittent PMSE detected at 450 MHz.

Incoherent Scatter Spectral Theories: Modeling the spectrum for modes propagating perpendicular to B.

Kudeki

From IEEE Transactions on Geoscience and Remote Sensing, Vol. 49, No 1, January 2011.



A sample trajectory depicting the simulated motion of an electron in a magnetized O^+ plasma (electron density $N_e = 10^{12}\,\mathrm{m}^{-3}$, temperatures $T_e = T_i = 1000\,\mathrm{K}$, and ambient magnetic field $\mathbf{B} = \hat{z}25\,\mu\mathrm{T}$) undergoing Coulomb collisions. The left panel on the top shows the simulated trajectory in 3D space, while the remaining panels depict the motion components perpendicular and parallel to $\mathbf{B}$. The trajectory was sampled every $\Delta t = 0.1\,\mu\mathrm{s}$, and a total of 4000 samples over a $400\,\mu\mathrm{s}$ interval are shown. The red dots indicate the initial location of the particle (the origin), while the red curves depict the first $1.4\,\mu\mathrm{s}$ of the trajectory (about one gyro-period). The simulated electron motion is governed by a Langevin equation (a stochastic differential equation) including the Lorentz force and speed dependent friction and diffusion coefficients. The simulations are used in establishing a spectral model for radiowaves Thomson scattered from the Earth's ionosphere as described in *Milla and Kudeki* (2009).

Space Weather Educational Video on YouTube

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments:

The aeronomy section has sponsored a large number of programs involving education. Among these include the CEDAR workshops that enable students to connect and interact with faculty and researchers and to be exposed to current research in their respective areas. In addition, Research Experience for Undergraduates (REU) programs are supported, as well as national and international workshops related to aeronomy. Outreach activities have also been supported. An excellent example of this is the highlight noted below of a podcast space weather effects (Millstone Hill). Space Weather Educational Video (http://www.haystack.mit.edu/swfx)

Space Weather Educational Video

Coster (0455831)

Haystack Observatory has announced its first educational You Tube video: Space Weather FX. The video can be seen at http://www.youtube.com/watch?v=fZ-L-pS0syc entered under the category of "Science & Technology", with additional "tags" including space weather, Earth, sun, and GPS. This is the first program in what will be a 9 episode series. It is available in several forms for convenient computer viewing, including Quicktime, Flash, MPEG, and Windows Media Player (WMV) formats. The video podcast will also be available through iTunes, where users can subscribe to the series for download and easy viewing on iPods and compatible devices. The series' home website is at http://www.haystack.mit.edu/swfx

Space Weather FX was created by a team of producers in Massachusetts, with help and inspiration from the MIT Haystack Observatory Atmospheric Sciences Group, the National Science Foundation's Geosciences directorate (Upper Atmospheric Facilities division), NASA, and many other institutions.

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

Comments:

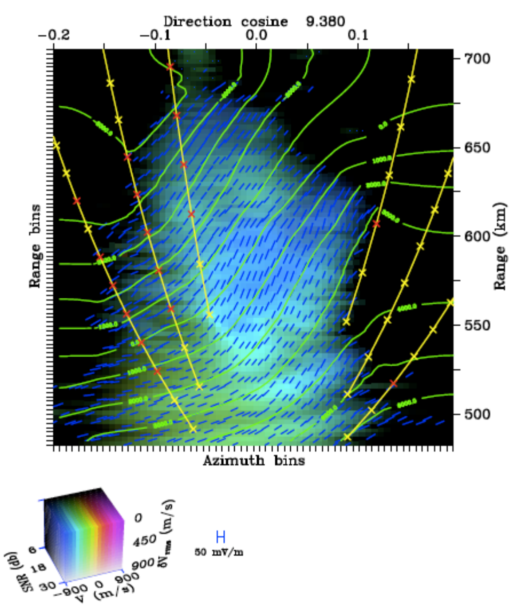
The section supports small instrumentation programs that are designed to obtain unique observational data of aeronomic processes to complement the Geospace Facilities infrastructure. Examples can be found in the highlights below using coherent scatter radar imagers (Hysell) and optical imagers (Makela).

See below for more details on some of the selected AER highlights.

Assessing auroral electric field variance with coherent and incoherent scatter radar and sounding rockets

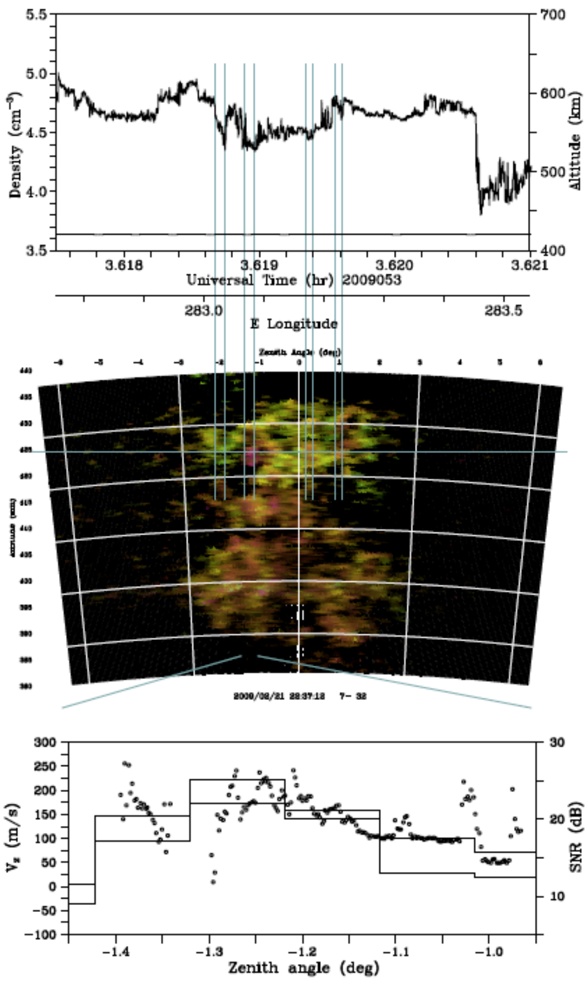
Hysell

The NASA JOULE II sounding rocket experiment was conducted in Alaska in January 2007 to evaluate the contribution of fine structure in the auroral convection electric field to ionospheric Joule heating, which depends quadratically on the electric field and is susceptible to underestimation if fine structure is neglected. The figure shows a coherent scatter radar image for Jan. 17, 2007, 0922 UT during an interval of strong southwestward convection. The backscatter intensity increased at this time to a peak of about 30 dB SNR, and the range spread of the echoes expanded to nearly fill the entire radar field of view. Vector drifts (blue lines) were estimated from the moments of the Doppler spectra in each cell of the two dimensional image. A convection pattern (green contours) was fit to the resulting drift estimates using statistical inverse methods. The largest convection speeds implied by the figure are nearly 1800 m/s in the northeast quadrant. During the observations, the RMS electric field estimated from the coherent scatter radar varied between about 45–65 mV/m, consistent with the PFISR ISR estimates. The ratio of the mean squared electric field to the squared mean field, with the averaging taking place over the imaging radar field of view, varied from about 1.2 to 1.5. This ratio gives an indication of the Joule heating rate underestimate resulting from neglecting of spatial electric field structuring on the scales present in the radar image shown.



Simultaneous, coincident observations of ionospheric plasma irregularities using Jicamarca and the C/NOFS satellite

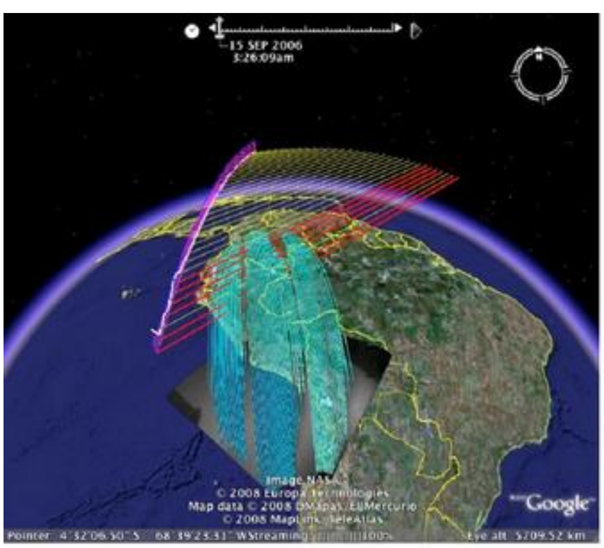
(C/NOFS proposal)



Hysell et al., [Geophys. Res. Lett., 2009] describe an experiment where the C/NOFS satellite flew over JRO while it was running in radar imaging mode. The former measured the plasma number density and drifts along its low-inclination orbital track at an altitude of about 425 km. JRO made images of backscatter power and Doppler spectra as functions of time and zenith angle in the plane of the magnetic equator where strong backscatter from ionospheric irregularities is visible. The figure compares the plasma number density measured by C/NOFS (top panel) with JRO radar imagery (middle panel). The results indicate that the most intense radar backscatter detected at the satellite altitude came from regions of depleted plasma. One of those depleted regions is examined in detail in the third panel of the figure, which compares the vertical plasma drift seen by C/NOFS (plotter symbols) with the radar backscatter intensity (dashed line) and Doppler shift velocity (solid line). The comparison shows that the Doppler shift of the backscatter is a reliable telltale of the plasma drift in the depleted given region.

New Insights into Ionospheric Irregularities

Makela (0517641)



Ionospheric irregularities can cause severe degradation of radio waves, such as those used for satellite communication and navigation signals, that propagate through them. New insights into the field-aligned structure of irregularities near the equator have been made by using a suite of instruments located at the National Science Foundation (NSF) sponsored Cerro Tololo Inter-American Observatory. Prof. Jonathan J. Makela and his team in the Remote Sensing and Space Sciences group in the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign have used an ionospheric imaging system to obtain images of the depletions in the Earth's ionosphere associated with the irregularities. Using these images, an estimate of the ionospheric volume affected by the irregularities can be obtained and extruded along the Earth's magnetic field lines to the conjugate hemisphere. When combined with GPS-occultation data from the COSMIC/FORMOSAT-3 constellation of satellites, estimates of irregularity scattering heights can be made by examining where the satellite occultation links intersect with the ionospheric volume obtained from the images. The preliminary study confirms that irregularity scattering altitudes are typically confined to altitudes near the peak density of the ionospheric F-layer.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas. None noted.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions. We think that aeronomy is doing an outstanding performance with constrained budgets. We are appreciative of the development of multi-disciplinary opportunities across disciplines, (i.e. FRONTIERS)

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance. See main COV report.

C.4. Please provide comments on any other issues the COV feels are relevant. See main COV report.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template. COV process and format was adequate. Report template was hard to work with. A word document should have been mailed out. More small break-out rooms should be pre-arranged. Healthier coffee breaks and breakfast.

SIGNATURE BLOCK:

MAG

FY 2010 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: May 4-6, 2011
Program/Cluster/Section: Magnetospheric Physics
Division: AGS
Directorate: GEO
Number of actions reviewed: **Awards: 14** **Declinations: 21** **Other: 1**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 100** **Declinations: 136** **Other: 20**
Manner in which reviewed actions were selected: **individually chosen to cover a broad mix of actions**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The Program Officer used appropriate review methods, including mail-in reviews, face-to-face panels, and virtual panels. The panels were well balanced with reasonable diversity of gender and professional background, including theory, modeling, and data expertise. In many cases the mail-in reviews appeared to be more detailed and of higher quality than the panel reviews. Source: Jackets and the EIS. Select the "Type of Review" module.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: Both review criteria were addressed at all levels. The individual reviews were often unbalanced, indicating a clear disparity among individual scientists in their views of the relative importance of the two criteria. The panel summaries and the Program Officer's Review Analyses contained more balanced and thorough considerations of the two criteria.	a) Yes b) Yes c) Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

Source: Jackets	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: Individual reviews varied considerably in level of detail and the justification for the opinions and advice. Mail-in reviews tended to be higher quality. Source: Jackets	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Panel summaries provided a good synthesis of the individual reviews and rationale for the panel consensus, which could differ from the initial opinions expressed in the individual reviews. Source: Jackets	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments:	Yes

The Magnetospheric Program Officer provided clear documentation in the Review Analysis summaries describing the justification for the selections made. The Program Officer demonstrated excellent judgment, utilizing the input from the panel members and reviewers while also weighing appropriately the often wide ranging views expressed by the reviewers. The Program Officer gave careful consideration to all views expressed and indicated where the reviewer input factored heavily in the funding decision and where the input was discounted, with appropriate rationale. Regarding ARRA-funded proposals, none of the awards in MAG that were enabled by the ARRA involved reversals of decisions to decline. As a sample, however, we examined the ARRA-funded proposals from the 2009 GEM solicitation. All of these proposals were in the upper half of the ranked projects in the panel recommendations. One was “Highly Recommended;” three were “Recommended” in the second or third rank (of six that were in the “Recommended” category); and one was “Recommended” in the fourth rank. Four of the five were new PIs. It was clear that the ARRA funds allowed the program officer to fund very meritorious proposals (expanding the number of awards from 8 to 13), as well as to provide an encouraging start for entry-level scientists. It is our judgment that even with the ARRA supplement, very meritorious research proposals still had to be declined, indicating that the high-quality proposal pressure is very intense in this program. Source: Jackets	

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The documentation to the PI describes clearly the rationale for the decision, including details from the reviews and panel summaries as well as programmatic issues described in the Review Analyses. Source: Jackets	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision.	Yes

Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The time to decision for Mag proposals was slightly longer than the NSF Performance Goal. In 2008 and 2010, 69% and 53% of the decisions were made within six months. 79% and 74% of the decisions were made within nine months. Decisions were made on a longer time frame in 2009 due to ARRA funding. Source: Jackets and EIS-Web COV module. Select "Report View", then select "Average Dwell Time," and select any combination of programs or program solicitations that apply.	
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? The Magnetospheric Physics program was highly effective at using the merit review process.	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[2]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Reviewers with broad and appropriate expertise were used. Source: Jackets	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: A balanced group of reviewers was used, including representation of minorities, disabled, institution types, and gender. The number of reviewers from minority groups is difficult to assess given the small number who report this information. Source: Jackets and EIS-Web COV module. The "Report View" has reviewers	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

by state, institution type, minority status, disability status, and gender.	
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Conflicts of interest appear to have been recognized and resolved. Source: Jackets	Yes

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The quality of the research and educational programs is high. The relatively small fraction of proposals that can be funded ensures that the process is highly competitive. The selection process is fair and well documented. The quality of the research is demonstrated by the high peer-review rating and by the productivity of the investigators. Some proposals are selected primarily based on scientific merit, whereas others are selected based on broader impact, based in part on education and minority participation. It is also the cast that at times some of the highest rated proposals based on science were not funded due to the priority of maintaining institutional balance. It is difficult to assess the outcome and impact of the proposals selected based on broader impacts. Source: Jackets and program information	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: The integration of research and education was used as an explicit factor in the selection of a number of the proposals. Source: Jackets and program information	Yes
3. Are awards appropriate in size and duration for the scope of the projects? Comments:	Yes

[3] If "Not Appropriate" please explain why in the "Comments" section.

The projects are scoped for the size and duration of the typical award size by the proposers. The reviewers take the project scope into consideration in their assessments. Source: Jackets and EIS-Web COV module has a "Report View" that gives average award size and duration for any set of programs or program solicitations you specify.	
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The overall program has an appropriate balance of transformative projects. Proposal reviews and assessments of the Program Officer demonstrate a recognition of and support for innovative approaches, provided the methodology to pursue them is clear. Source: Jackets and program information.	Yes
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Approximately 15% of the funded Magnetosphere portfolio consisted of inter- and multi-disciplinary projects. Source: Jackets, program information, and some people use as a proxy data on jointly funded projects. See EIS-Web COV module, "Report Review" and select "co-funding from" and "co-funding contributed to" to find jointly supported awards.	Yes

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Although the award size is generally smaller than would be probably be optimal, the balance of single and multiple investigator awards seems appropriate. Source: Jackets, program information, and EIS-Web COV module for information on award size.	Yes
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: The fraction of all awards given to new PIs ranged from about 10% in 2008 to 32% in 2009 and 22% in 2010. Source: EIS-Web COV module on “Funding Rate,” filtered by PI Characteristic (use the pop-up filter).	Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators?	Yes

Comments: The PIs are geographically well distributed, reflecting the distribution of educational and research institutions.	
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: The portfolio is reasonably balanced among institution types.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: The Magnetosphere portfolio is well balanced among subdisciplines. In particular, the GEM program has been quite successful at insuring that a balanced distribution of subdisciplines are the focus of funding opportunities. Source: Jackets and program information	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups?	Yes

Comments: There is a fairly uniform funding rate among various underrepresented groups. Source: EIS-Web COV module, using "Funding Rate" with the pop-up filter (this allows you to see female and minority involvement, where involvement means being PI or co-PI).	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The Magnetosphere program is highly relevant to national priorities as expressed by the US National Space Weather Program and well aligned with NSF's mission, including discovery, education, and infrastructure. Source: Program information	Yes
13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards). ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: The Magnetosphere program is extremely well managed. The Program Officer solicits diverse and balanced reviews, and demonstrates excellent judgment in synthesizing the information obtained. Careful consideration is given to all reviewer input, and compelling justification is given for the final decisions.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The Magnetosphere Program Officer is highly responsive to emerging research and education opportunities. Through the GEM program, the Program Officer solicits community input on emerging directions and funds targeted proposals. The Program Officer identifies and funds potentially transformative research and demonstrates a priority for fostering strong education activities.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The Magnetosphere Program Officer actively engages the scientific community in planning the portfolio and prioritizing new directions. The Program Officer regularly informs the community on priorities identified by NSF, such as cross-disciplinary research, to ensure that the magnetosphere community is able to respond effectively to opportunities that arise. Within NSF, it is clear that the Magnetosphere portfolio is well aligned with the Agency's explicit priorities: discovery, learning, and infrastructure.
4. Responsiveness of program to previous COV comments and recommendations. Comments: The MAG-specific portion of the 2008 COV commented on several aspects of the program. It is somewhat difficult to judge what level of response they have received. In our judgment several of the comments probably didn't really require response. However, we do think it would be worthwhile for the program director to give consideration to the 2008 COV suggestions regarding 1) encouraging study of comparative magnetospheres, perhaps through cooperation with the Astronomy Division, and 2) increased site visits,

particularly for evaluating infrastructure awards.
5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

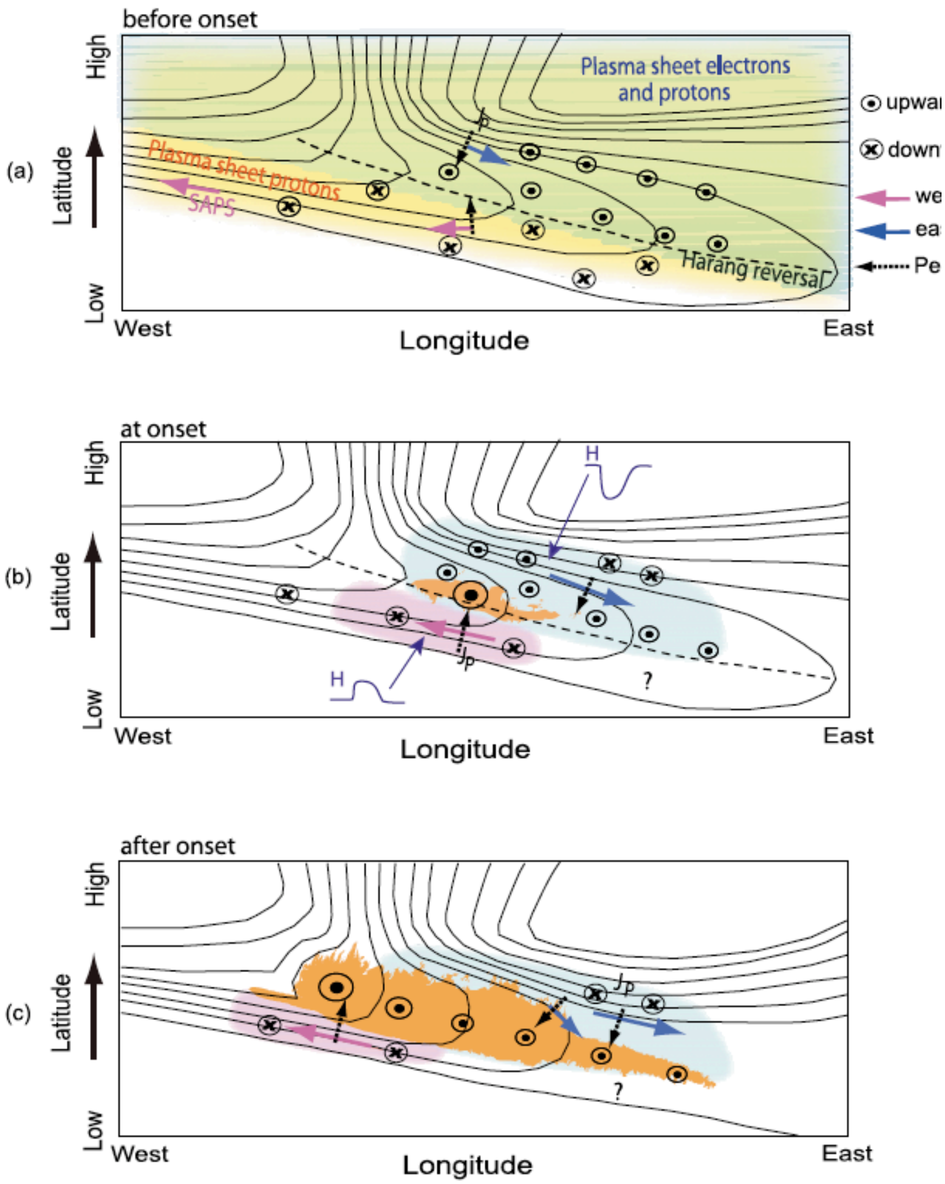
To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*" This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments: Most of the projects in the MAG portfolio have a strong foundation in Discovery. The scientific merit of the proposals is a primary criterion in their selection, and MAG-funded projects have made significant contributions to advancing the frontier of knowledge. This is true of both the base program and the targeted programs like GEM.

Three examples:



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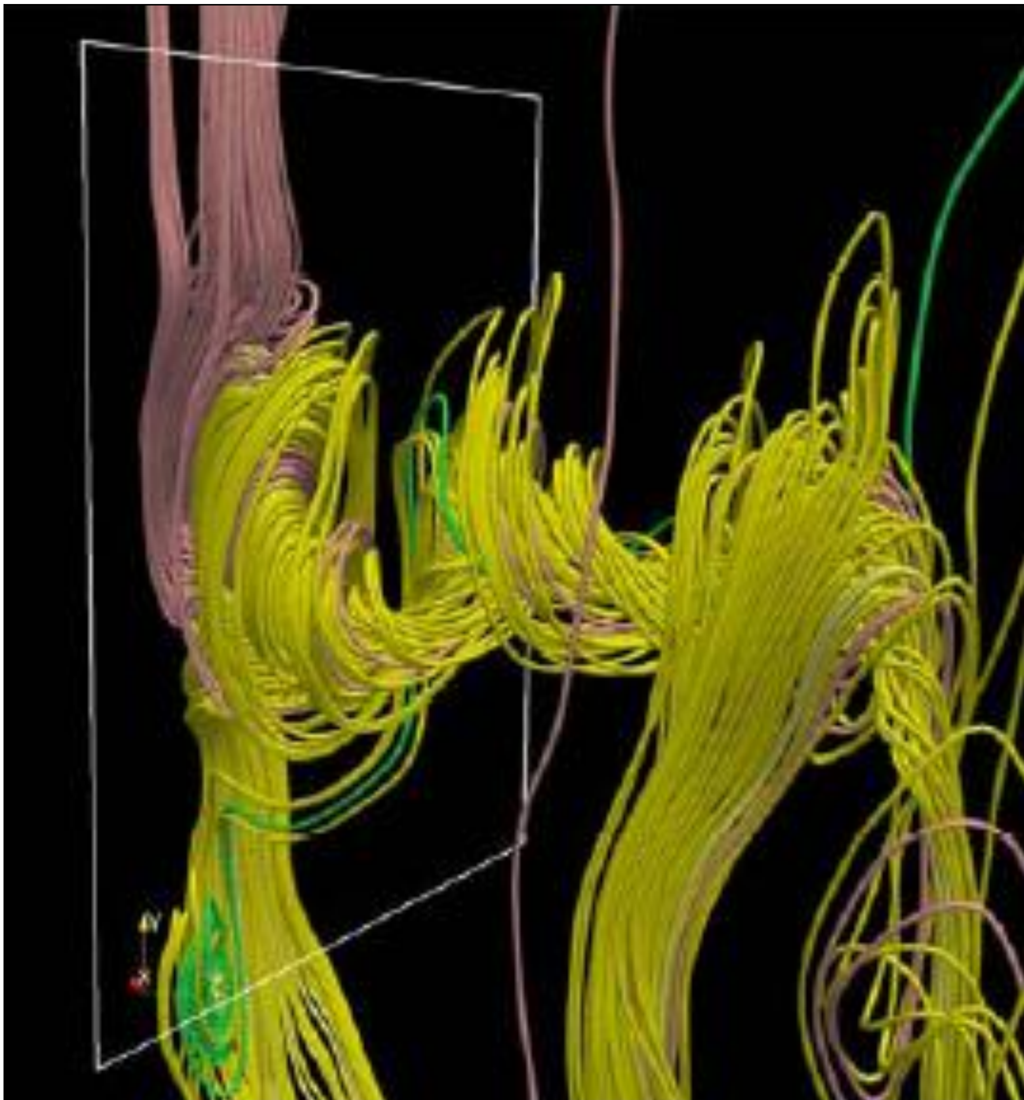
Zou et al., J. Geophys. Res., A12301, 2009.



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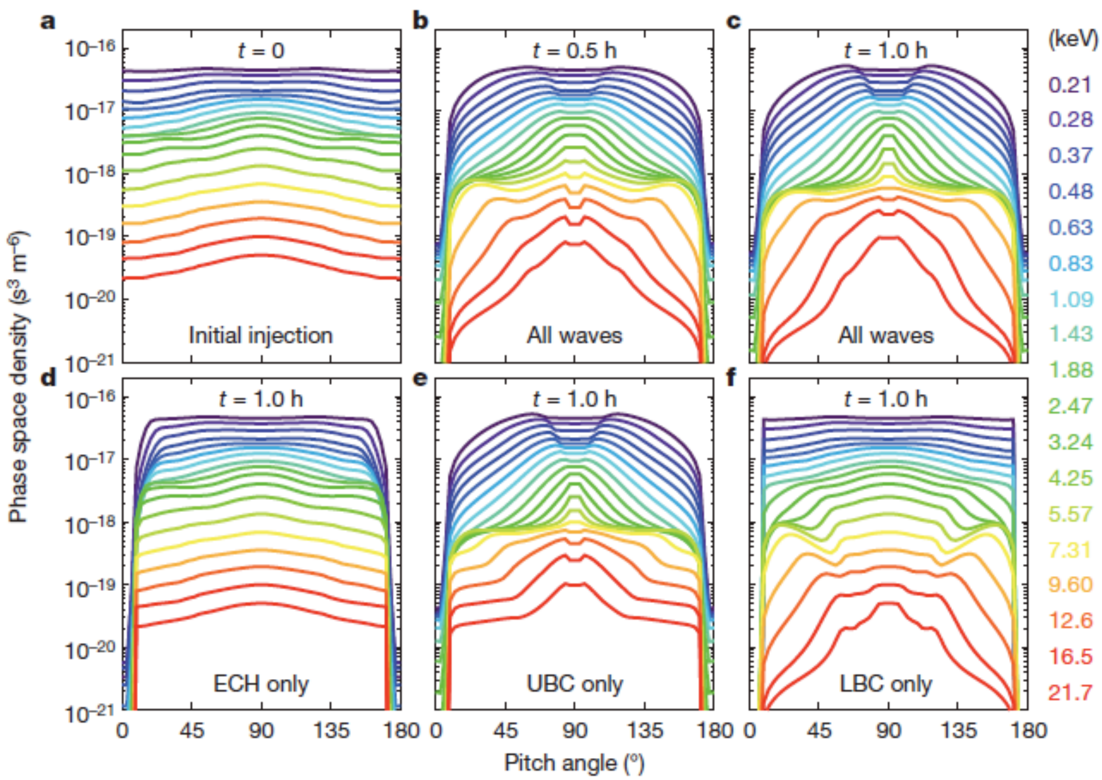
LETTER

Scattering by chorus waves as the domin
diffuse auroral precipitation

Richard M. Thorne[1], Binbin Ni[1], Xin Tao[1], Richard B. Horne[2,3] & Nigel P. Meredith[2]



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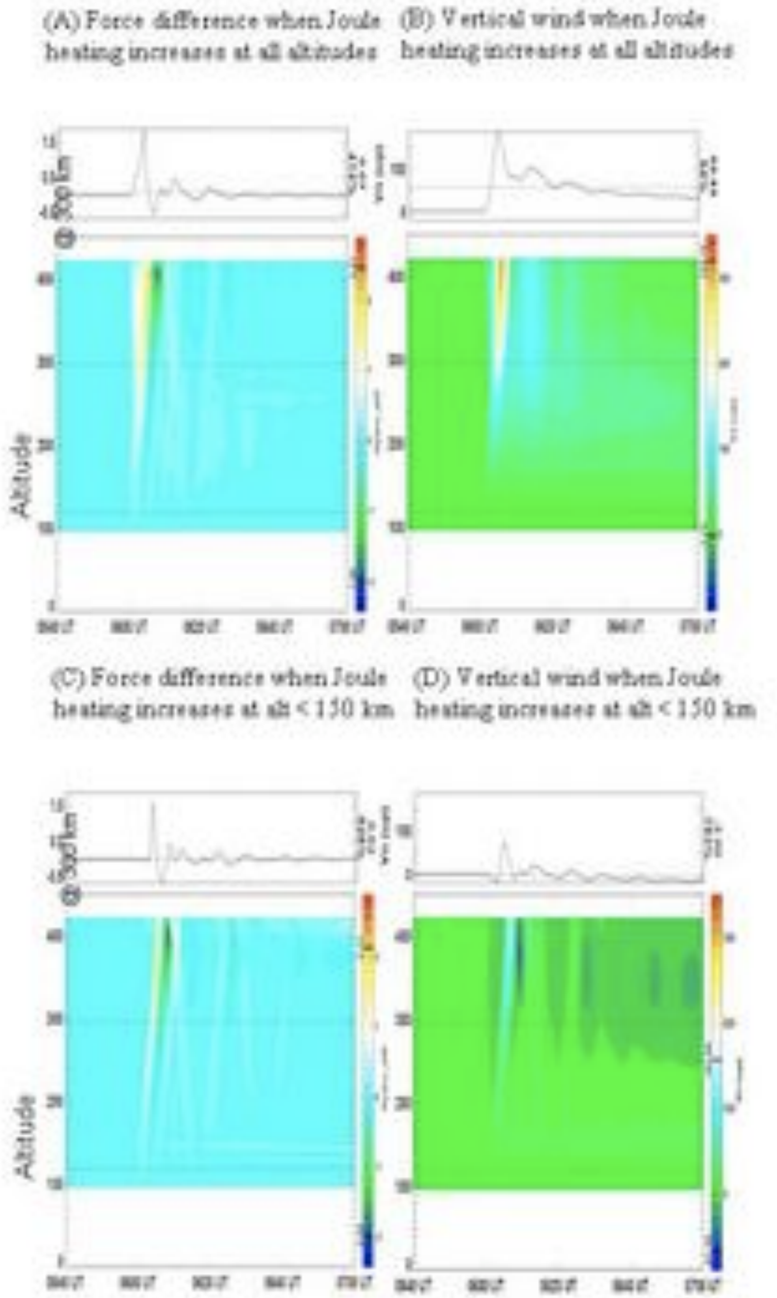
B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"
This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments: The emphasis on the importance of development of the workforce, particularly relating to undergraduate, graduate, and under-represented populations, is evident throughout the review and award process. In a few cases it even trumps the assessed quality of the proposed science. The outcome of these efforts is somewhat difficult to assess, but there are noteworthy success stories.

Two examples:

W. Paterson REU 0755202

Research Experiences for Undergraduates summer program held at
an historically-black university. Participants included eleven undergr
different universities, plus three Hampton graduate students. Stude
four research groups: (1) Space weather and planetary magnetosph
aerosols, (3) Global climatology of H_2O, CH_4, O_3, and NO_2 in the str
stratospheric ozone and aerosol retrievals from limb scattering mea



T. Fuller-Rowell
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150 km altitude

B.3 <u>OUTCOME GOAL for Research Infrastructure: "</u>*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

This category includes facilities, research instrumentation, and cyberinfrastructure.

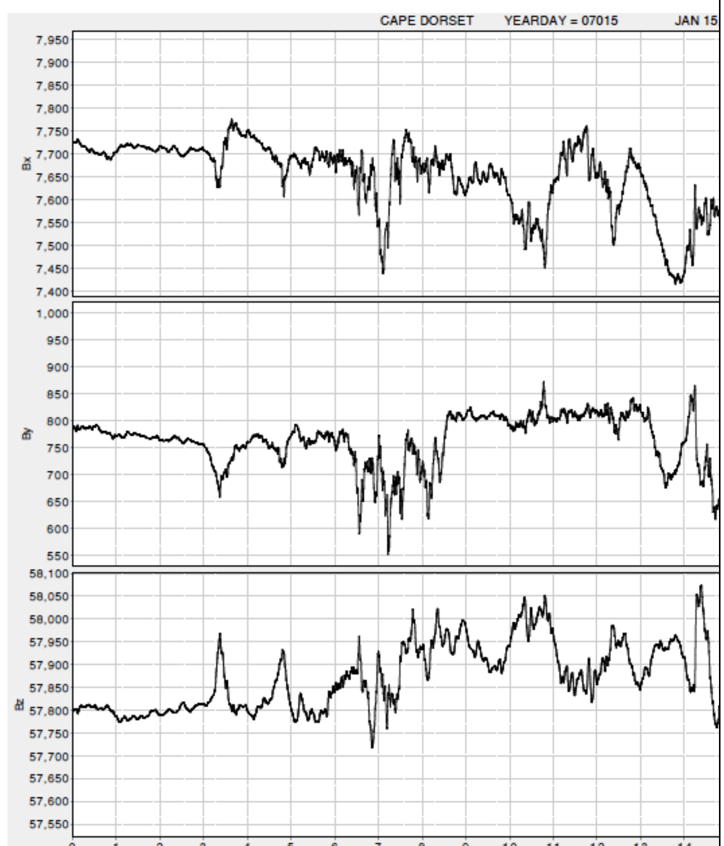
Comments: In addition to supporting major research facilities reviewed by the GF subpanel of the COV, awards through the MRI program provide new or expanded observational capabilities that will enable important new scientific progress. Many of these grants simultaneously provide valuable hands-on experience to undergraduate and graduate students, thereby giving even more return on the NSF investment.

One example:

M. Engebretson MRI 0827903

The Magnetometer Array for Cusp and Cleft Studies (MACCS) is an a
magnetometers located at nine sites in the Canadian Arctic. Many o
internet connections with sufficient speed to allow downloading of
the site to the MACCS data system at Augsburg College. Additional
that are currently not connected to the internet are expected over t
data are made available to the public via the MACCS web site http:/

Data have been used by researchers in the U.S., Canada, the United Kingdom, Japan, and Finland. The data have been used in conjunction with measurements from the NASA THEMIS mission, and data from European Cluster satellite mission.



PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

C.4. Please provide comments on any other issues the COV feels are relevant.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

SIGNATURE BLOCK:

____

For the [Replace with Name of COV]
[Name of Chair of COV]
Chair

STR

FY 2010 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: May 4-6, 2011
Program/Cluster/Section: Solar-Terrestrial Research
Division: AGS
Directorate: GEO
Number of actions reviewed: **Awards: 14** **Declinations: 15** **Other: 0**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 77** **Declinations: 124** **Other: 25**
Manner in which reviewed actions were selected: **individually chosen to cover a broad mix of actions**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[4]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Source: Jackets and the EIS. Select the "Type of Review" module.	Yes
3. Are both merit review criteria addressed d) In individual reviews? e) In panel summaries? f) In Program Officer review analyses? Comments: For the files reviewed this was done relatively consistently both by the individual reviewers and in the panel summaries. This was particularly well done in the PO review analysis (reflecting good discussion in the panels) Source: Jackets	Yes

[4] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: There are some reviews that are rather brief and a bit lacking in substantive comments. In such cases the PO normally noted this and weighed them accordingly. Source: Jackets	Mostly
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Source: Jackets	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) iii) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. iv) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: There were no ARRA awards which involved reversal of decisions in the Solar-Terrestrial subsection.	Yes N/A

Source: Jackets	

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: For the files reviewed, the rational for award/decline decisions were quite thorough and well done. Source: Jackets	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: Exceeded target goal in all three years and well above target goal in 2 of the 3 years. While 2009 was achieved only at the 75.5% level (still above target goal), this was simply a function of the ARRA.	Yes

Source: Jackets and EIS-Web COV module. Select “Report View”, then select “Average Dwell Time,” and select any combination of programs or program solicitations that apply.	

8. Additional Comments

c) Additional comments on the quality and effectiveness of the program’s use of merit review process.

Appears PO did everything possible to select quality reviewers and to obtain quality reviews.

d) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

This was a bit obscure and difficult to determine. Of the proposals funded by ARRA, only those that were ranked near the top of the list by the reviewers (i.e., “fund if possible”) were selected.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[5]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: While difficult, it appears, based on the subset of proposals reviewed, that the PO did his best to select a qualified and well balanced set of reviewers. Source: Jackets	Yes
3. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: This is extremely difficult to discern given that only ~25% of the reviewers self reported. It "seems" that qualified reviewers from the above demographics were selected when possible. Source: Jackets and EIS-Web COV module. The "Report View" has reviewers by state, institution type, minority status, disability status, and gender	Not able to determine.
3. Did the program recognize and resolve conflicts of interest when	Yes

[5] If "Not Applicable" please explain why in the "Comments" section.

appropriate? Comments: It appears every effort was made to achieve this. Numerous comments were made in the PO summaries explaining when such conflicts arose and how they were handled. Source: Jackets	

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[6], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Source: Jackets and program information	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: Very apparent that the integration of research with education (students/post docs) is deemed important and supported where possible/appropriate. Source: Jackets and program information	Appropriate
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Typical award sizes (~100k) and durations (~3 years) seem to have remained the same over the last several years and likely are not keeping pace with inflation. There is pressure on proposers to promise more for less to earn awards. Source: Jackets and EIS-Web COV module has a “Report View” that gives average award size and duration for any set of programs or program solicitations you specify.	Appropriate (with qualifications)

[6] If “Not Appropriate” please explain why in the “Comments” section.

4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: Of proposals reviewed, those with innovative/potentially transformative projects were duly noted and considered (in a positive light) when weighing pros and cons for funding. Source: Jackets and program information.	Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Source: Jackets, program information, and some people use as a proxy data on jointly funded projects. See EIS-Web COV module, “Report Review” and select “co-funding from” and “co-funding contributed to” to find jointly supported awards.	Appropriate

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Although the award sizes for NSWP and SHINE do not vary much, the CAREER and MRI awards are significantly larger giving the overall portfolio sufficient balance. Source: Jackets, program information, and EIS-Web COV module for information on award size.	Appropriate
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: ARRA funded proposal had a higher rate of new investigators. Source: EIS-Web COV module on “Funding Rate,” filtered by PI Characteristic (use the pop-up filter).	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators?	Appropriate

Comments:	
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments:	Appropriate
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: No statistics provided based on discipline or subdisciplines. Source: Jackets and program information	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments:	Appropriate

Source: EIS-Web COV module, using "Funding Rate" with the pop-up filter (this allows you to see female and minority involvement, where involvement means being PI or co-PI).	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: Conclusion based on external reports such as that from "Report of the Assessment Committee for the National Space Weather Program" (2006) Source: See	Appropriate
13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards). ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding? A large number of high quality proposals are unfunded each year. Even in 2009, when supplemental funds were provided by ARRA, this was true. Enhancement of the STR budget is clearly needed.	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: The program is very well managed and detailed documentation regarding the rationale for decisions is provided. The feedback to the PIs is adequate to understand the funding decision and is given in a timely manner. The portfolio is balanced with adequate attention being given to new PIs, underrepresented groups, and general diversity.
2. Responsiveness of the program to emerging research and education opportunities. Comments: PO seems very responsive to emerging research and educational opportunities. For example, the PO is very conscience about attending the annual SHINE meetings and responding to the specific research and programmatic funding needs emerging from that venue. PO normally willing to take the time to listen to STR community needs and adequately address them where possible. Educational needs appropriately considered/weighed in grant proposals. Several CAREER awards have been made over the last three years.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: From examination of the selected proposals, it is clear that high scientific merit is the primary priority with a careful examination of the broader impacts being used to more finely tune the selection process. Balance within the solicited programs (e.g., SHINE, NSWP) is well considered, but is less clearly so for unsolicited proposals.
4. Responsiveness of program to previous COV comments and recommendations. Comments: The program has been quite responsive to the previous COV comments and recommendations. Significant consideration was given to these and concrete steps have been taken where appropriate.

5. Additional comments on program management: The STR subcommittee recommends that when proposals are evaluated strictly through write-in evaluations and the results reveal a large disparity of views/ranking, that the PO consider holding a brief telecon (comprised of those that wrote the evaluations) so that they can discuss their findings as a group.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

In addition to identifying particularly noteworthy accomplishments or "highlights," the COV is encouraged to comment on the impact of NSF supported contributions to the field. For example, the COV report may include comments on NSF supported work in context of contributions to advance a field, impact of NSF investments to stimulate emerging new areas, and potential for transformative impact in research or education.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*
This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments: The STR program has resulted in many new and exciting scientific research developments and breakthroughs. We highlight here just a few examples.

(1) Alfvén Waves in the Solar Corona (Award 0541567): Scott McIntosh and his collaborators (Tom Bogdan, Mats Carlsson, Bernhard Fleck, Stuart Jefferies, and Phil Judge) demonstrated that the Sun's magnetic field allowed the release of Alfvén wave energy from its interior, through thin fountains flowing upward into the solar chromosphere.

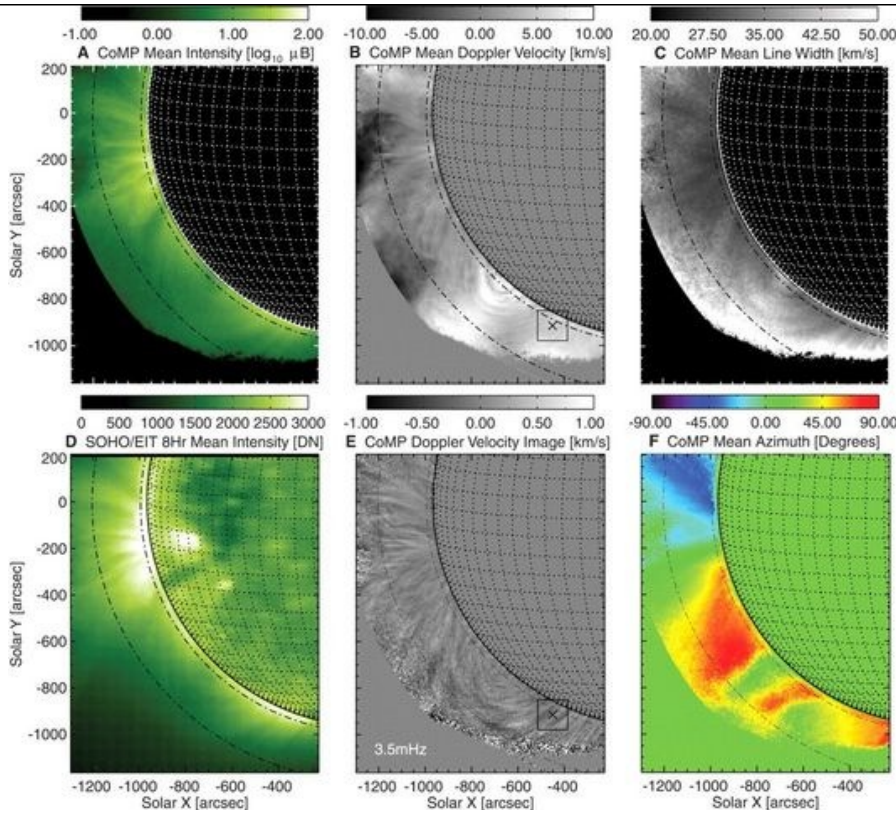


Fig STR-1 From left to right, top to bottom: *CoMP observationsof time-averaged intensity (A),Doppler velocity (B), line width (C), SOHO/EIT 19.5-nm imagery (D), 3.5-mHz filtered Doppler velocity (E), and plane-of-sky magnetic field azimuth direction (F). Note that 'DN' (data number) is a unit of brightness. Images (B) and (E) indicate a region (X) used by investigators for Alfvén wave travel-time analysis. The curved dot-dashed lines represent distances of 0.05 and 0.25 solar radii above the Sun's limb.*Credit: Steven Tomczyk, NCAR

(2) Simulations of Quiet Sun Magnetic Fields (Award 0737836): Dr. William Abbett of the University of California at Berkeley has developed a completely new 3D numerical model called 'RADMHD' that simulates, in a physically self-consistent manner, the Sun's upper convection zone, photosphere, chromosphere, transition region, and solar corona.

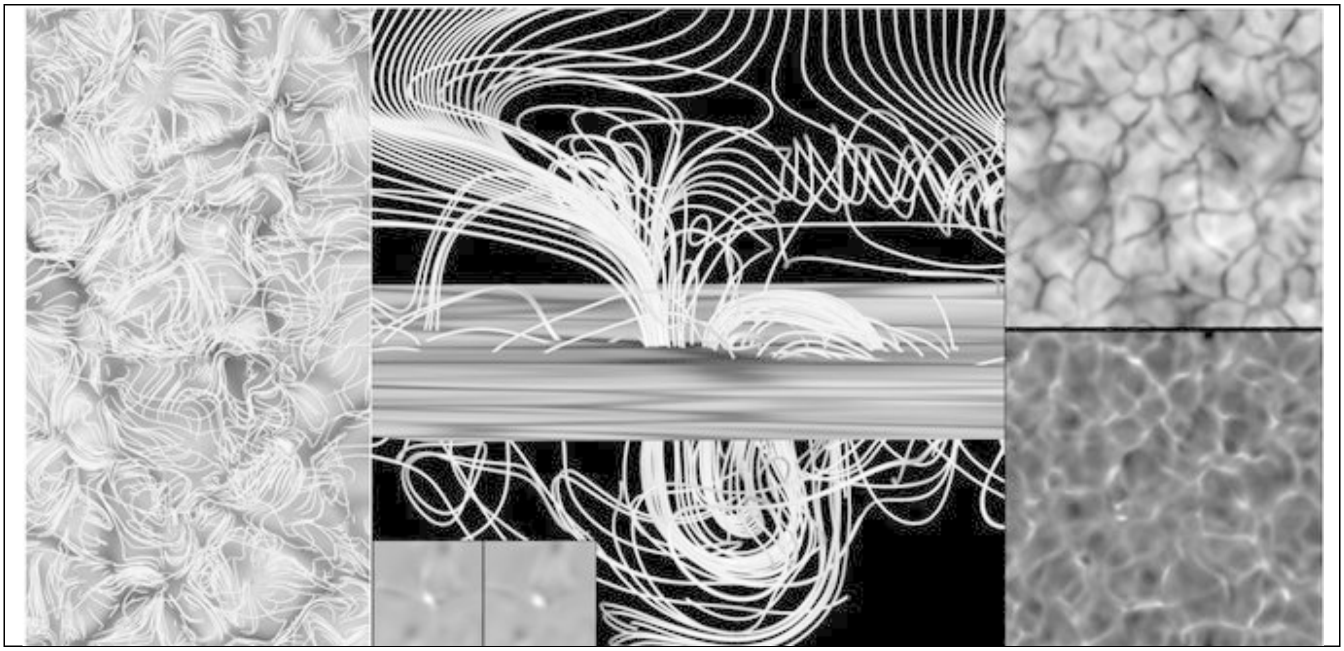


Fig STR-2 Simulation of Quiet Sun magnetic fields generated by the action of a convective dynamo: ***Left image****: Magnetic field lines in the modeled solar chromosphere;* ***Center image****: Zooming in on a magnetic flux submergence event;* ***Right image****: Temperature fluctuations at the Sun's visible surface (top) and in the solar chromosphere (bottom). Credit: Dr. William Abbett, University of California at Berkeley.*

(3) Solar Plasma Flow Velocity Analysis (Award 0451438): Dr. Brian Welsch of the University of California at Berkeley has recently published with his colleagues the results of one of the first comprehensive studies of plasma flow velocities in the Sun's lower atmosphere, and described how these flows are associated with solar flare activity.

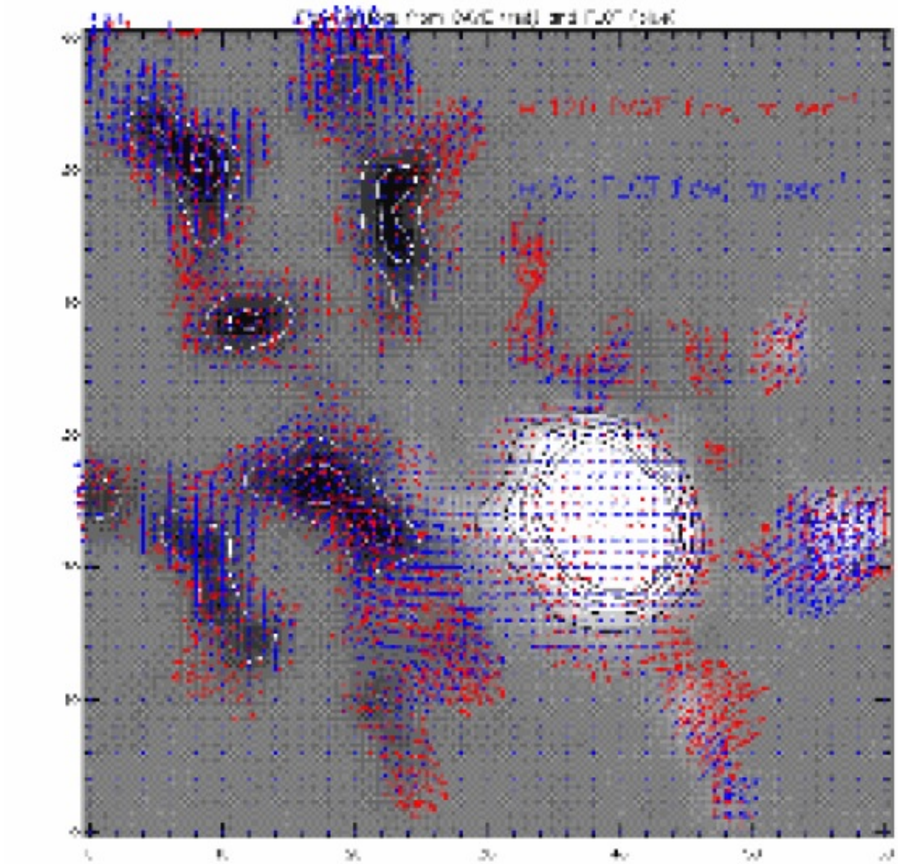


Fig STR-3 *This image shows photospheric plasma flow vectors estimated by applying two tracking methods, 'DAVE' and 'FLCT,' to a pair of successive, line-of-sight (LOS) magnetograms of active region AR 8038, taken by a spacecraft on 12 May 1997. The background grayscale shows the average LOS solar magnetic field; black is negative magnetic polarity, white is positive; contours show LOS magnetic field strengths in 100 Gauss increments from 100 - 500 Gauss. Red vectors show flows estimated using DAVE and blue vectors show flows estimated using FLCT.*
Credit: Dr. Brian Welsch, University of California at Berkeley

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

STR has contributed to supporting world-class science and engineering workforce primarily through its REU and CAREER awards. REU programs such as the one hosted at Montana State University (Fig STR-4) have been instrumental in providing undergraduates with high quality research experiences and encouraging a new generation of scientists. STR supported 5 REU sites during the period examined by the COV.

REU Site: Solar Physics Program at Montana State University, PI David McKenzie, Award 0552958

Fig STR-4. *The 2007 Solar and Space Physics REU students at Montana State University: Murphy Breyfogle, Daniel Bruder, Christopher Daly, Philip Fernandes, Nicholas Hill, Sarah Joy, Chris Lowder, Daniel Mardit, Joshua Swanson, Peter Wyper, Letisha McLaughlin, Lynsey Thorton, and Anthony Yeates.*

STR funded seven CAREER awards during this period. The work of one of these (Fig STR-5) also contributed to STR's efforts to increase the public scientific literacy.

CAREER: Understanding the Evolution and Nature of Shocks and Sheets in Space Physics, PI Merav Opher, Award 0747654

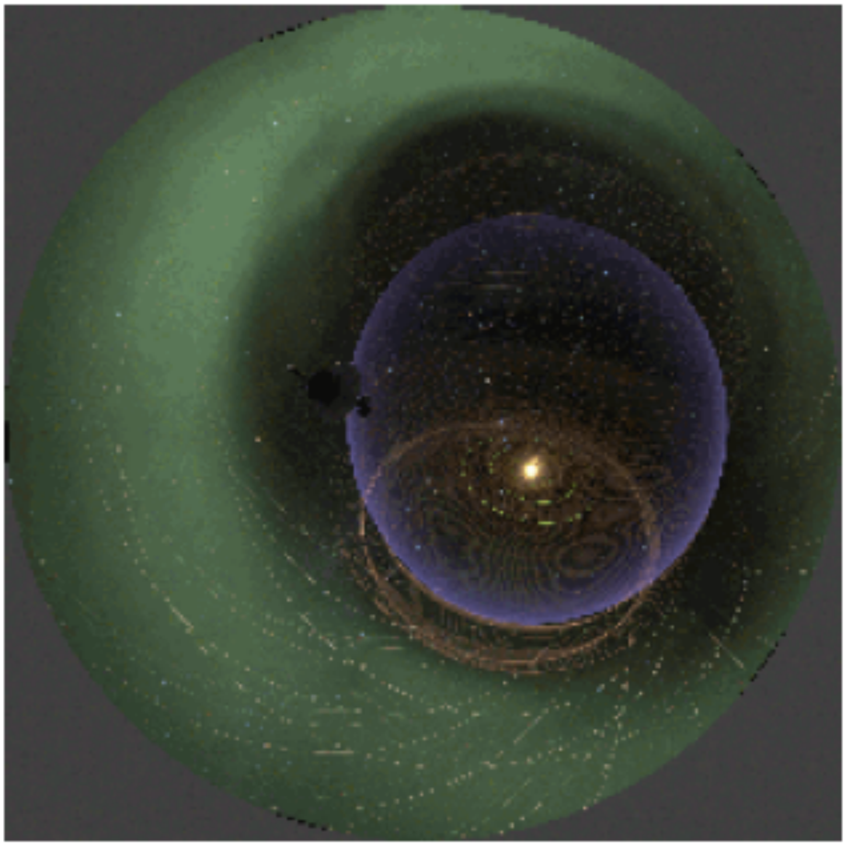


Fig STR-5. *A still image from the planetarium show Journey to the Stars was created by Dr. Merav Opher as part of a longer video sequence. This graphic depicts the Voyager 2 spacecraft looking back at the Sun and solar system from beyond the heliosphere's termination shock (the magnetic "bubble" seen in purple), and just short of reaching the heliopause (the magnetic sheath shown in green). The magnetic field lines that drape around the heliosphere are drawn in yellow/orange.*

B.3 <u>OUTCOME GOAL for Research Infrastructure:</u> "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

This category includes facilities, research instrumentation, and cyber infrastructure.

Comments: STR has contributed to building the nation's capability through supporting MRI awards and awards developing models and tools to enable state-of-the-art science to be performed. Some examples are given below.

MRI: Development of Owens Valley Solar Array to a Community Facility, PI Dale Gary (Award 0959761)

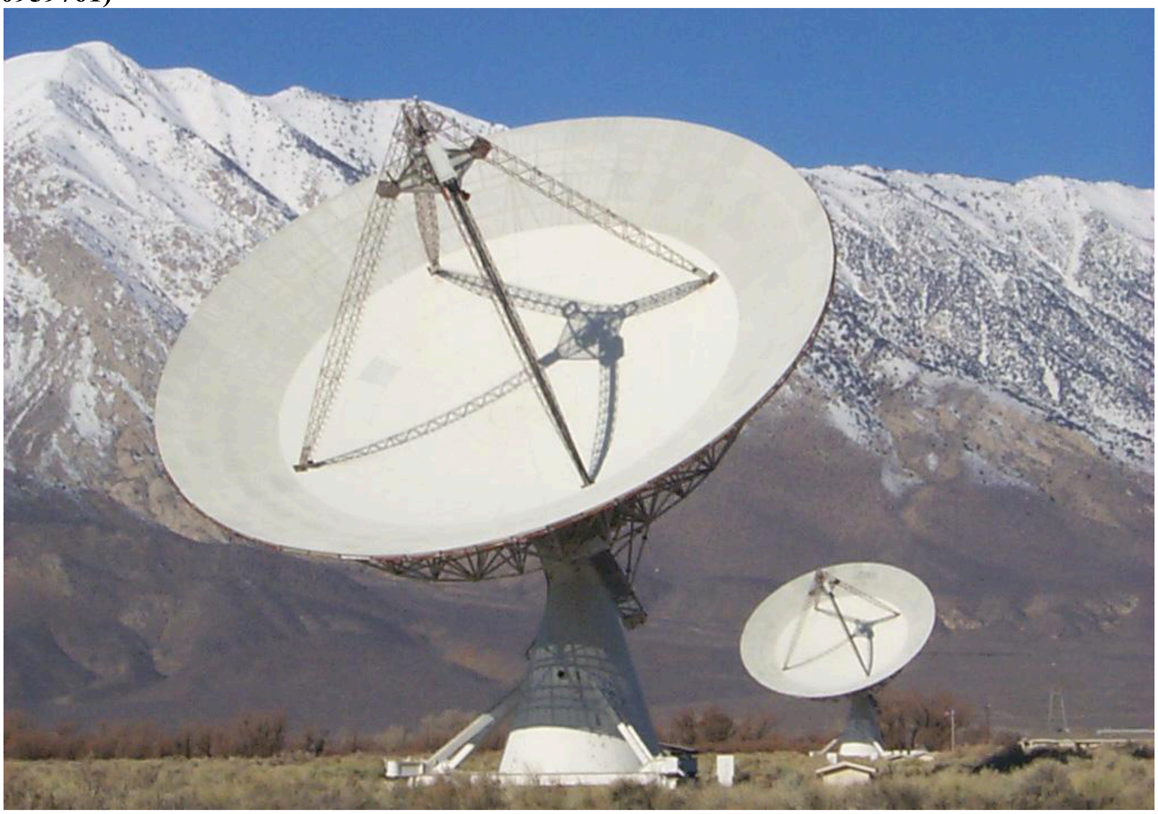


Fig STR-6. *The New Jersey Institute of Technology will upgrade the Owens Valley Solar Array from its current complement of 7 antennas to a total of 15 resulting in a world-class community facility for solar physics research at microwave radio frequencies in the range of 1-18 GHz.*

Partnership in Basic Plasma Science & Engineering (PBPSE) (Award 0531621): Dr. Walter Gekelman is the PI of the $3M/yr interagency PBPSE program focusing on fundamental research in interdisciplinary plasma science and engineering. **(**STR and MAG Program Directors have collaborated with the NSF Physics Division in order to fund UCLA’s Basic Plasma Science Facility)

Fig STR-7. *The Basic Plasma Science Facility (above) performs frontier-level research of the plasma state of matter. Usage of the facility is available to qualified scientists from national and international institutions, and industry.*

3D Reconstructions of Solar Coronal Mass Ejections (Award 0331513): Dr. Bernard Jackson's team at the University of California, San Diego, as well as his colleagues at the Air Force Research Laboratory and NASA, are using SMEI data for real-time analysis and 3D interpretation of the heliosphere.

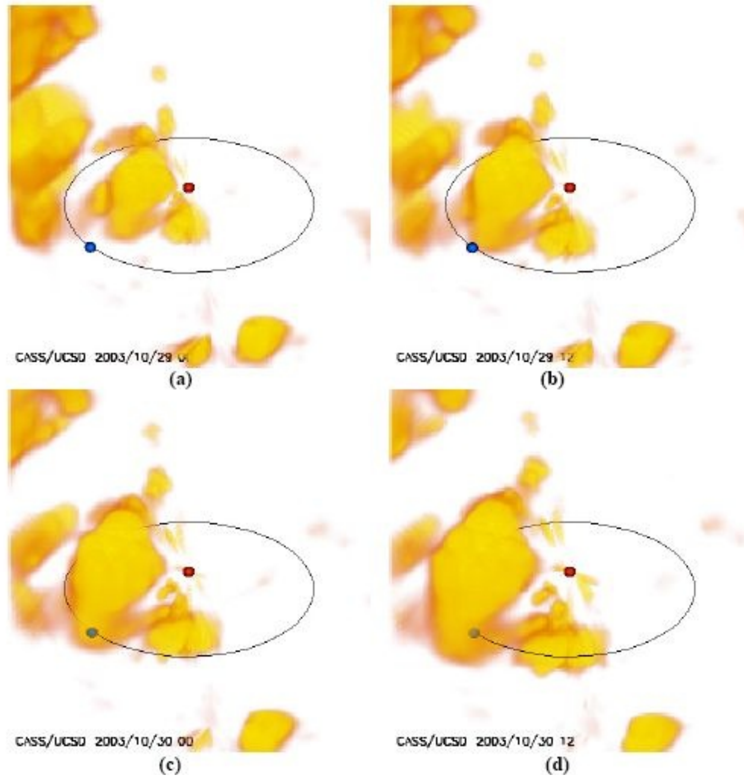


Fig STR-9. *3D reconstructions of the 28 October 2003 CME, at four successive times. (a) 28 October 2003, 00hrs; (b) 28 October 2003, 12hrs; (c) 30 October 2003, 00hrs; (d) 30 October 2003, 12hrs. These images depict views from an arbitrary point 3 astronomical units (AU) away from, and 30º above, the ecliptic plane. The Earth (blue sphere), its orbit (ellipse), and the Sun (red sphere) are all indicated. Dense CME plasma clouds are depicted by the yellow 'blobs' and the large October CME can be seen to cross the Earth's orbit (and finally engulf the Earth) in the successive images.*

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

C.4. Please provide comments on any other issues the COV feels are relevant.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

SIGNATURE BLOCK:

____

For the [Replace with Name of COV]
[Name of Chair of COV]
Chair

GF

FY 2010 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: May 4-6, 2011
Program/Cluster/Section: Geospace Facilities
Division: AGS
Directorate: GEO
Number of actions reviewed: **Awards: 27** **Declinations: 17** **Other: 1**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 37** **Declinations: 72** **Other: 36**
Manner in which reviewed actions were selected: **The selection process consisted of selecting UAF proposals that were both declined and accepted with about 50% accepted and 50% rejected. The ARRA proposals were selected with the same intent. About 1/3 of the reviewed items were ARRA submissions. The physical facilities, CubeSat and research instrumentation programs were considered. About 45 proposal actions were reviewed by the UAF team.**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

The COV wishes to commend the UAF Program director for his effective management and the direction he has taken the program. The UAF program has benefited from the addition of new instrumentation, as well as new concepts to operate them. The newly operational AMISR facility has exceeded sensitivity expectations. The program has supported the high demand for observing time. The support for additional instrumentation at the facility will provide more research opportunities for the community. Competitions targeted to the use of facilities, such as the AMIR graduate studies, should be encouraged to broaden their user base. Finally, the UAF program supports excellent educational and outreach activities at the facilities

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[7]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The GF section has employed a variety of review methods for its programs, including site visits, panels, and written reviews. The methodologies applied were well designed and appropriate.	YES
4. Are both merit review criteria addressed g) In individual reviews? h) In panel summaries? i) In Program Officer review analyses? Comments: Both of the NSF merit review criteria were directly addressed in individual reviews, panel summaries, and Program Officer review analyses.	YES

[7] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: In general, most individual reviewers provided substantive comments and adequate justification for their assessments. As expected, there is some variability in the efforts of mail-in reviewers. The Directors and/or panels clearly took this variability into account in balancing their final assessments.	YES
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Panel summaries were thoughtful and well written. The typical panel summary included a project synopsis, a bulletized list of strengths and weaknesses, and a narrative explaining how consensus was reached.	YES
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) v) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. vi) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The “Review Analysis” files prepared by the program director were, in general, impressively detailed, providing a very clear rationale for the decision. In some cases, the final decisions reflect some subjectivity in the balance of merit criteria applied by the Director. In one case reviewed, this balance differed from the panel judgment. But the Director’s decision was, nonetheless, fully explained and justified. Such director discretion is appropriate.	YES

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: Judging from the panel summaries, individual reviews, Review Analyses, and direct discussions with the program directors during this review process, it is felt that ample rationale was conveyed to the PI for the jackets reviewed.	YES
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The average time-to-decision has increased across AGS over the past 5 years, growing from just under 6 months in 2005 to over 7 months in 2010. The "dwell time" is currently about 1 month above the NSF average. TYhe GF average is somewhat longer than the AGS average, with 30% of proposals exceeding 9 months. These numbers are within acceptable bounds, but there is also some concern. The cause is probably related to several factors, including the introduction of the Cubesat initiative (increasing proposal pressure). This issue is closely connected to staffing needs, as discussed in the introductory remarks. Source: Jackets and EIS-Web COV module. Select "Report View", then select "Average Dwell Time," and select any combination of programs or program solicitations that apply.	YES

8. Additional Comments

   e) Additional comments on the quality and effectiveness of the program's use of merit review process.

   f) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[8]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The GF program relied on mail-in review, panels, and site visit committees to inform their decisions. For the new Cubesat program, panels consisted of both engineers and scientists. For facility proposals, the reviewer pools consisted of scientists connected with similar facilities, as well as scientists more peripheral to the interests of the facility. In general, reviewers were well-qualified. In cases where a reviewer was not an expert in the subject area of the proposal, it was usually obvious. In these cases, appropriate balance was applied to emphasize the more knowledgeable reviewers.	YES

[8] If "Not Applicable" please explain why in the "Comments" section.

4. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Based on the self-reported demographic statistics, it is clear that the GF program made an effort to use a diverse reviewer pool. In fact, efforts to achieve this objective probably placed an extra burden on scientists associated with certain underrepresented groups.	YES
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Reviewers are asked to self-identify potential conflicts of interest and to help the program director understand the severity of the conflict. Conflicts of interest were appropriately addressed in all identifiable cases.	YES

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[9], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The GF program is pursuing an exciting portfolio of research topics, and is actively supporting education of the next generation of scientists. With the inclusion of the Cubesat initiative GF supports a uniquely rich variety of platforms and science objectives.	YES
2. Does the program portfolio promote the integration of research and education? Comments: The facilities are each engaged in the educational mission of NSF, but in different ways. For instance, Millstone Hill and Arecibo have active REU programs and ties to Boston University. SRI hosts student groups at Sondrestrom and strongly supports student users of the facilities it manages.	YES

[9] If "Not Appropriate" please explain why in the "Comments" section.

The Cubesat program also actively and directly engages students (including undergraduates) in this program. Overall, the facilities program receives high marks for integrating research and education.	
3. Are awards appropriate in size and duration for the scope of the projects? Comments: The duration and size of awards is appropriate. In most cases (cooperative agreements and cubesats) the duration is essentially fixed by programmatic considerations. The size of Cubesat awards is typically very close to stated budget limits. This is a testament to the inadequate funding levels available for these projects. Source: Jackets and EIS-Web COV module has a "Report View" that gives average award size and duration for any set of programs or program solicitations you specify.	YES
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The Cubesat program is potentially transformative on two levels: technical and scientific. It is too early to judge whether this transformative potential will be realized, but this high-risk/high-reward program is strongly endorsed by this committee, as discussed in the report summary. Selection of ARRA projects was based on a couple of different criteria. While an effort was made to address transformative research and technologies, the short timeline was also a driver. Although some ARRA selections were drawn from the existing pool of highly-rated proposals, the selections nonetheless were made based on optimizing transformative potential.	YES
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The ISR facilities are inherently interdisciplinary within the context of AGS in that the facility diagnostics can be used to support a broad range of research topics. Facility research is suitably interdisciplinary, as revealed in the	YES

renewal proposals. The Cubesat initiative provides a unique new opportunity for interdisciplinary research. The selected Cubesat proposals reflect a balance between topical diversity and likelihood of success. Cubesats, it should be noted, are by their very nature interdisciplinary: the science and engineering teams are closely integrated and are communicating in order to solve a shared problem. Source: Jackets, program information, and some people use as a proxy data on jointly funded projects. See EIS-Web COV module, “Report Review” and select “co-funding from” and “co-funding contributed to” to find jointly supported awards.	

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Projects supported under GF have a broad range of funding levels. The cooperative agreements that fund the major facilities include specific funding for named Co-Investigators and senior personnel. The Cubesat selections have typically involved multi-institutional collaborations.	YES
7. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: The GF program does not typically fund new investigators. The nature of facility development and management typically requires a minimum level of experience as a professional scientist. However, the facilities do support new investigators within their budgets. ARRA awards made under the GF program were also heavily concentrated on experienced PIs.	YES
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The program appropriately reflects the geographical distribution of the community.	YES

9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: There has been long-term continuity in both the institutional management of the existing facilities and in the selection of the institutions selected to develop the new instruments and facilities, such as AMISR. This is appropriate in view of the extensive baseline engineering and administrative infrastructure needed to carry out these tasks. Nonetheless, the recompetition of the Arecibo management contract is considered a healthy exercise, demonstrating a responsiveness to changing realities. Cubesat selections have been appropriately balanced.	YES
10. Does the program portfolio have an appropriate balance: • Across disciplines and subdisciplines of the activity? Comments: In recent years, the ISR facilities have seen a shift away from plasma physics research and towards neutral dynamics. This may reflect a bona fide shift in community priorities, but care should be taken to maintain core ionospheric research activities and the necessary incoherent scatter expertise at the facilities.	YES
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: No evidence of bias in this area is perceived. The location of some of the facilities ensures a large representation of Hispanic scientists, several of whom have become exceptional members of the community.	YES
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.	YES

Comments: The program is relevant to key national priorities. Principal among these national priorities are education, training of future scientists and engineers, and space weather. Section B contains several examples of relevant work in these areas. The Cubesat program also provides a means to build capacity in the space industry. Source: Program information	

13. Additional comments on the quality of the projects or the balance of the overall portfolio (including ARRA funded awards).

ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?

The UAF portfolio is well balanced. The ARRA projects reflected that balance and did not skew the selection in a particular direction. All of the selected projects were of very high quality.

More projects could have been selected. The ARRA funding opportunity indicates that the current funding levels are insufficient to fund many of the exciting, innovative, and important projects that are proposed.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:
The committee is impressed with the dedication of the staff to the management of the program.

With respect to Geospace Facilities, they are clearly dedicated to providing state-of-the-art instrumentation to the community and to providing the infrastructure required for a healthy and growing research program.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The recent development of the Cubesat program, which represents an important new initiative within the broader research program, as well as the continuing work on the installation of the RISR instrument at Resolute Bay is clear evidence of the responsiveness of the program to emerging research needs and opportunities. The staff has also been very responsive to educational opportunities, both in connection with the annual CEDAR workshop, in funding special schools such as PARS, and in the ongoing support for graduate students and postdocs, including the CEDAR postdoc program.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The internal planning and prioritization process that guided the development of the portfolio was carried out with care and competence. The staff clearly receives and cares about external input to the process and pursues advice actively, but as pointed out elsewhere in the report, the staff can benefit from a more formalized external advisory committee process.
4. Responsiveness of program to previous COV comments and recommendations. Comments: The majority of the recommendations from the previous COV have been addressed, either by implementing a change or by determining that the recommendation could not be implemented in a practical manner. There were a few minor recommendations that were not addressed, but the lack of a response in those cases appears to be due to limited staff or time resources. The committee therefore finds that the staff has been responsive to the previous recommendations overall.
5. Additional comments on program management: We commend the staff for the efficient management of the program, for working to develop new research opportunities within the program, and for their responsiveness to the needs and concerns of the community.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to promote the progress of science; advance national health, prosperity, and welfare; and secure the national defense (NSF Act of 1950).

In this Section, the COV is asked to comment on (1) noteworthy achievements based on NSF awards in the portfolio under discussion; (2) ways in which funded projects have collectively affected progress toward NSF's mission and the strategic outcome goals of Discovery, Learning, and Research Infrastructure: and (3) expectations for future performance based on the current set of awards.

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To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio. The COV is asked to use this information, members' own knowledge of the field, and other appropriate information to develop its comments for this section.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."* This category includes NSF's disciplinary and interdisciplinary research in science and engineering, education research, and centers.

Comments:

During the period considered in the review, the UAF program has, within the funding available, supported the measurement of key upper atmospheric parameters and developed a new program, the NSF Cubesat program, that addresses an exciting new mode for NSF to contribute as a global leader in fundamental and transformational research.

Cubesats have an enormous potential for discovery and transformative research. Our review of the proposals supports the notion that there is a tremendous untapped reservoir of creative approaches to solving key science problems relevant to this discipline. The large number of Cubesat proposals that were submitted for the last two competitions form the basis for a program that can have a long

and successful history, but the low acceptance rate, limited by the relatively small available budget, may quickly lead to a loss of interest by the community.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"
This category includes K-12, undergraduate, graduate, and postdoctoral education and training; public understanding of science; and lifelong learning.

Comments:

UAF supports excellent educational and outreach activities at the facilities. Most have either an REU site , or a similar program every summer. Many of the most successful scientists in the field have started and benefited from these programs. The UAF also supports the Polar Aeronomy and Radio Science School in Alaska, which helps develop expertise in the next generation of scientists (http://www.gi.alaska.edu/students/PARS)

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"
This category includes facilities, research instrumentation, and cyberinfrastructure.

Comments:

The COV notes that the UARS program continues to develop key instrumentation.
The development of a Cubesat program sponsored by NSF represents a key advance in the nation's research capability by supporting the development of new experimental tools.

The Cubesat program has brought a new excitement and potential for discovery to the Aeronomy program at NSF. There has been tremendous proposal pressure during the first few years of the program, indicating a strong interest in the program on the part of the community. The NSF program directors responsible for the program deserve credit for their leadership in this effort and for their vision in the development of the program. The large number of Cubesat proposals that were submitted for the last two competitions form the basis for a program that can have a long and successful history, but the low acceptance rate, limited by the relatively small available budget, may quickly lead to a loss of interest by the community. The program needs to be adequately funded to maintain a reasonable acceptance rate and to reduce the pressure on the current Aeronomy budget. The submitted proposals have presented a broad range of innovative approaches to miniaturizing instruments and for new measurement strategies that can be adapted to the small Cubesat form factor. The educational value for students working on Cubesat projects seems clear, but the potential scientific value of the missions is still not completely clear.

Scientists use innovative Radio Aurora Explorer satellite to discover conditions that cause disruptions in space-based communication and navigation signals

An NSF-funded ISR radar in Resolute Bay, Canada, which is similar to the ISR used in this study.
Credit and Larger Version

March 16, 2011

Space weather-based disturbances in the Earth's upper atmosphere cause disruptions that affect space-based communication and navigation signals, such as GPS and radio signals.

Radio Aurora Explorer (RAX) is a space weather research satellite that is designed to investigate the causes of these weather disturbances.

RAX is the first satellite constructed under the National Science Foundation (NSF) CubeSat-based Space Weather and Atmospheric Research Program. Since September 2008, the project has been carried out jointly by SRI International, an independent, nonprofit research institute headquartered in Menlo Park, Calif. and the University of Michigan in Ann Arbor, Mich.

About 40 students worked on various satellite subsystems at different stages of the project, the majority of them from the University of Michigan. Three students from Worcester Polytechnic Institute visited SRI and worked on the radar.

"RAX demonstrates that low-cost cubesat missions that are mainly designed, built and operated by students as part of their university education and training can provide key measurements for space weather research and monitoring," said Therese Moretto Jorgensen, a program director in the Division of Atmospheric and Geospace Sciences at NSF.

Professional team members include principal investigators Hasan Bahcivan of SRI and James Cutler from the University of Michigan, as well as approximately 10 project managers and engineers.

"Space weather terminology took a hold in the last decade or so with the increasing public use of satellite technology and the vulnerability of spacecraft and space-based technology to solar and geomagnetic activity," explained Bahcivan. "Among many adverse effects of space weather is the degradation or disruption of space-based communication and navigation signals, for example, the Global Positioning System signals."

These degradations occur in the upper part of Earth's atmosphere between altitudes of 100-500 kilometers (62-310 miles) and are caused by geomagnetic storms. A geomagnetic storm is a disturbance of the Earth's magnetosphere, or the region in space where the Earth's magnetic field controls the motion of charged particles, in response to solar activity such as coronal mass ejections or solar flares.

"The effects of a geomagnetic storm include an increased population of radiation belt electrons, energetic particle precipitation into the Earth's upper atmosphere, auroras (northern lights) and strong electric currents in the ionosphere [a portion of the upper part of the Earth's atmosphere that is ionized by solar radiation]," said Bahcivan. "Space-based technologies, and in extreme cases, electric power grids on the ground become vulnerable during a geomagnetic storm."

Consequently, the effects of the disturbances include signal fading and phase distortions. For example, one type of distortion called scintillation, which is conceptually similar to the twinkling of the stars, can make GPS signals unusable.

To seek answers to where these disruptions occur and under what conditions, the RAX was launched on Nov. 21, 2010 via the Space Test Program aboard a Minotaur-4 vehicle in Kodiak, Alaska. According to Bahcivan, after a three-week period, the researchers conducted their first radar experiment using the Poker Flat Incoherent Scatter Radar, which is operated by SRI International under a cooperative agreement with NSF.

"Overall, the experiment showed that the radar system is working nicely," said Bahcivan. "Although background interference existed sporadically, it was manageable."

Bahcivan explained that RAX experiments must be conducted in coordination with ground-based radars. A typical experiment is conducted by illuminating a turbulent ionospheric region using a powerful ground-based incoherent scatter radar, or ISR.

An ISR is a scientific tool used for upper atmospheric and space physics research that takes measurements of the Earth's upper atmospheric and space regions from 60 kilometers (37 miles) up to 1000 kilometers (621 miles). Measurements taken by ISRs include ionospheric electron density, ion composition, plasma temperatures and electric fields.

In addition to the Poker Flat ISR, NSF supports other ISRs, including Sondrestrom in Greenland, Millstone Hill in Massachusetts, Resolute Bay in Canada, Arecibo in Puerto Rico and Jicamarca in Peru.

The RAX radar receives scattered signals from ISRs in space. However, some of the scattered signals arrive back at the ISR. These scattered signals contain information about the background properties of the particular region being tested.

By measuring plasma properties using non-turbulent background signals, scientists can determine which conditions give rise to plasma turbulence that cause degradation and irregularities in space-based signals. Scientists also can measure the electric field of the region, which provides critical information about plasma turbulence.

"Therefore, the goal of the RAX science mission is to determine which ionospheric conditions give rise to plasma turbulence," said Bahcivan.

"RAX helps provide better knowledge of fundamental physical parameters related to ionospheric irregularities," said Jorgenson. "This will lead to improved space weather models of the ionosphere that can predict the occurrence of irregularities and thereby help mitigate their adverse affect on systems that rely on trans-ionospheric radio waves, such as GPS."

Bahcivan explained that the RAX mission adds to ongoing efforts by measuring the irregularities with much higher spatial resolution and higher angular resolution with respect to the Earth's magnetic field, enabling a powerful diagnostic capability for ionospheric plasma turbulence.

-- Ellen Ferrante, National Science Foundation (703) 292-2204
emferran@nsf.gov

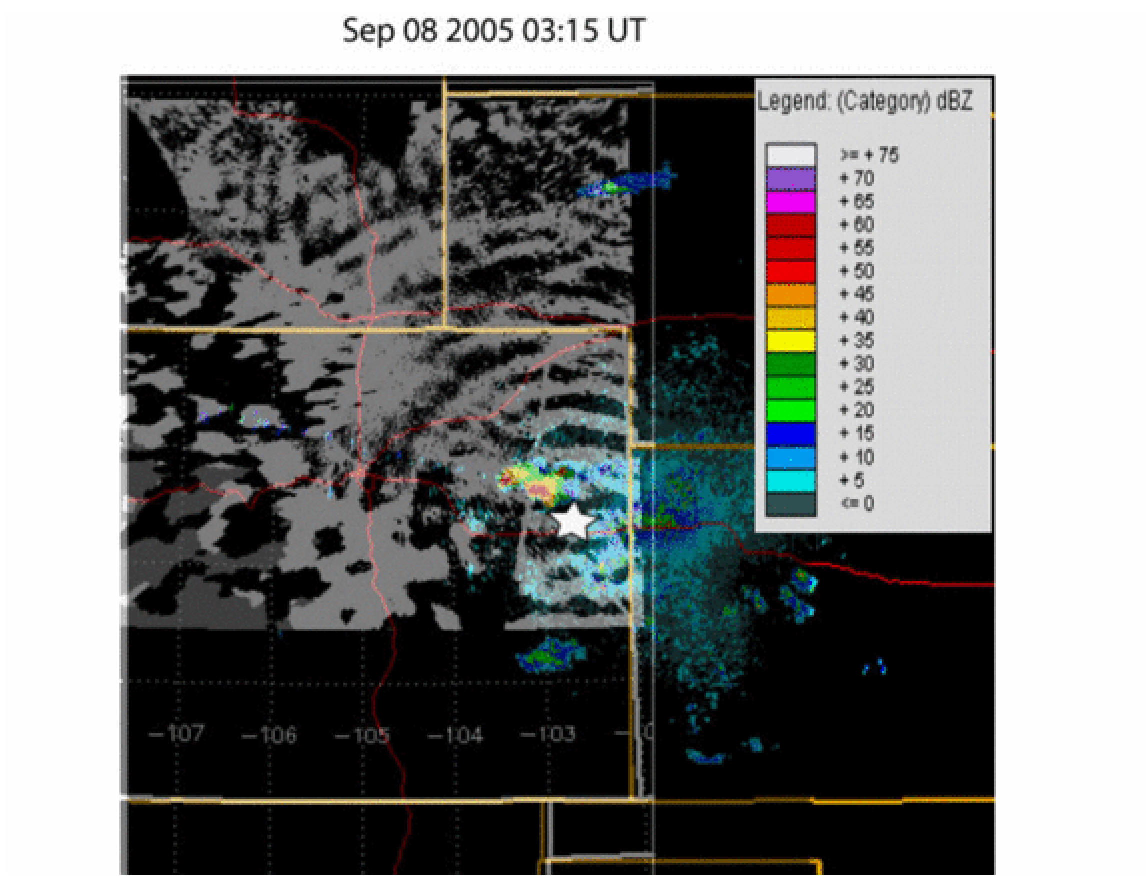
Related Awards
#0940277 CubeSat: Colorado Student Space Weather Experiment
#0838059 CubeSat: Dynamic Ionosphere Cubesat Experiment (DICE)
#0851916 REU Site: Space and Tropospheric Weather Processing Using DotSat
#0940313 CubeSat: CubeSat for Ions, Neutrals, Electron, and Magnetic Fields (CINEMA)
#0838046 Collaborative Research: CubeSat-based Ground-to-Space Bistatic Radar Experiment--Radio Aurora Explorer
#0838054 Collaborative Research: CubeSat-based Ground-to-Space Bistatic Radar Experiment--Radio Aurora Explorer
#0838015 Collaborative Research: CubeSat Firefly--Understanding Earth's Most Powerful Natural Particle Accelerator
#0838037 Collaborative Research: CubeSat Firefly--Understanding Earth's Most Powerful Natural Particle Accelerator
#0838024 Collaborative Research: CubeSat: Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics (FIREBIRD)
#0838034 Colllaborative Research: CubeSat: Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics (FIREBIRD)

Total Grants
$6,311,784

Coupling of the lower and upper atmosphere

Highlight ID: 16592, Version: AC/GPA

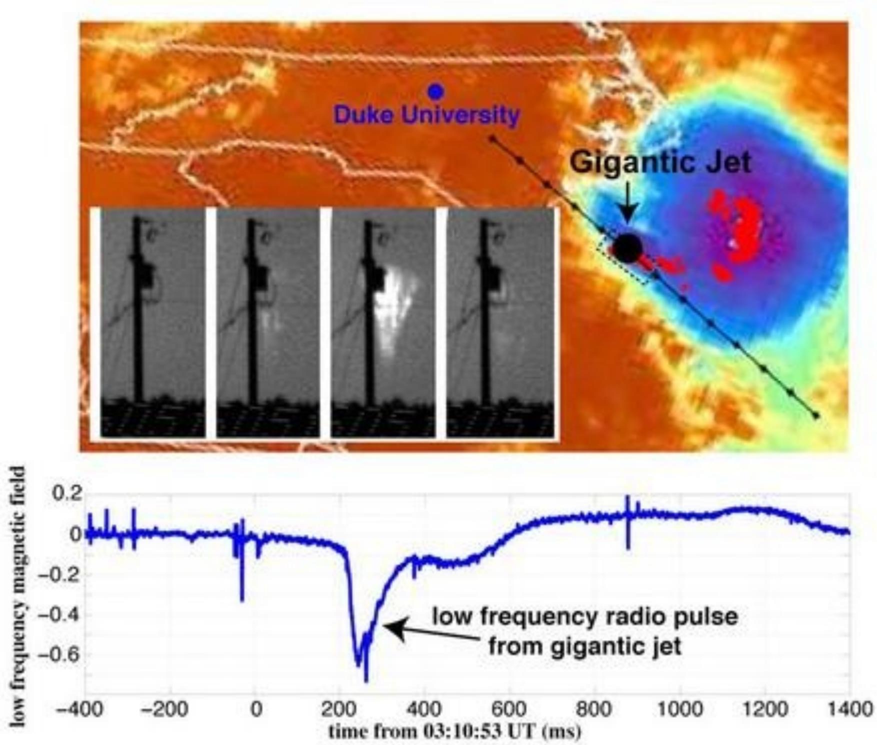
Atmospheric waves are prominent and ubiquitous features in the mesosphere and lower thermosphere, at altitudes of about 60 to 150 km. A particularly important feature of waves is that they carry energy and momentum from one region to another. The dynamics of the mesosphere and lower thermosphere, in fact, are largely controlled by waves. Using an all-sky imager located at Yucca Ridge, Colorado and provided by Professor Yukihiro Nakamura of Kyoto University, researchers at Colorado State University observed a rare signature of a convectively-generated gravity wave at a height of 87 km. Professors Chiao-Yao She and Steven Reising, working with graduate student Jia Yue, correlated the images with a thunderstorm that occurred in the lower atmosphere, below 15 km altitude. Like ripples produced by a stone that strikes a pond, the gravity waves from the thunderstorm radiate outward from the source but they also propagate upward. Examination of observations over a period of time showed that these patterns can be observed only during the equinox periods of March/April or September/October when the horizontal east-west winds between 15 and 87 km are weak. The figure shows an observed gravity wave pattern (with the epicenter marked by a star) overlaid on a NEXRAD radar image of the associated thunderstorm in the troposphere separated by ~30 min, the time it takes the wave to propagate from 15 to 87 km altitude. These observations demonstrate the transient, direct coupling of energy from the troposphere to the mesosphere and lower thermosphere region, lasting on the order of several hours.



Gravity waves observed in the upper atmosphere near 90 km over Colorado that were caused by a thunderstorm
Credit: Steven Reising and

Chiao-Yao She, Colorado State
University

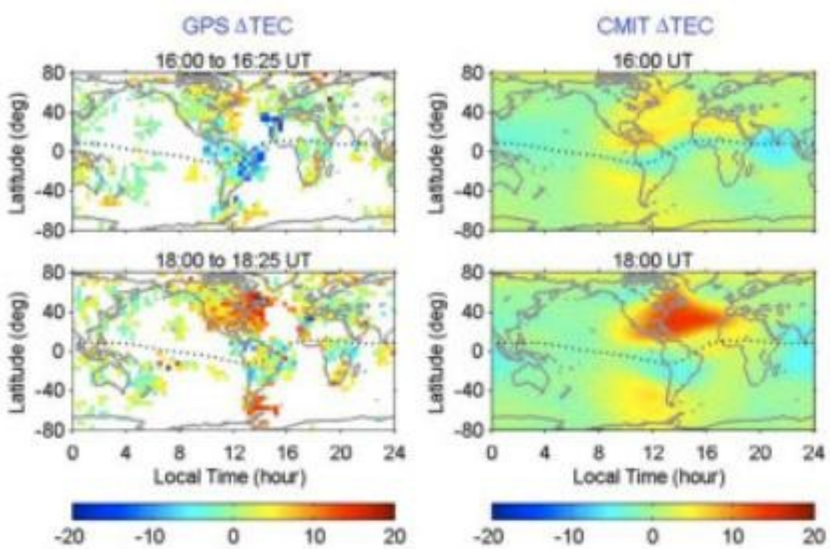
Unique observations of the "gigantic jet" over a thunderstorm
Highlight ID: 19041, Version: AC/GPA
Prof. Cummer and his students at Duke University, under an existing NSF grant, have made the first simultaneous recordings of the optical and radio signatures of a gigantic jet erupting from the clouds of signatures of a gigantic jet erupting from the clouds of a tropical storm and reaching the very edge of space near 90 km altitude. Gigantic jets were discovered in 2002 and are a form of electrical breakdown in thunderstorms that, instead of traveling downward and contacting the ground like ordinary lightning, travels upward out of the thunderstorm. The radio measurements show that the observed gigantic jet is very much like upward lightning and transfers as much electric charge directly to the upper atmosphere as a very strong lightning stroke transfers to the ground. This shows that gigantic jets are a newly recognized form of transient but strong coupling between the lower and upper atmosphere.



The development of the gigantic jet is shown in the middle panel of gray and white images, superimposed on a weather map. The bottom panel shows the radio pulse associated with the jet.
Credit: S. Cummer

Coupled Modeling of Space Weather Storm Impacts
Highlight ID: 16636, Version: AC/GPA
Among the most important and widespread impacts of space weather are those arising from changes in the earth's ionosphere during "geomagnetic storms", which

reflect a chain of complex physical processes beginning at the sun. By altering the density and distribution of charged particles in the ionosphere, storms degrade and disrupt systems ranging from communications to GPS navigation. The Center for Integrated Space Weather Modeling (CISM) is bringing together models of different parts of this system to understand, and ultimately to predict, the effects of such storms. Using the CISM Coupled Magnetosphere Ionosphere Thermosphere model, CISM researchers have simulated storm-time changes in the ionosphere's total electron content (TEC) and compared these model values with GPS measurements. The figure shows two time snapshots of modeled changes (right) and measured changes (left) in the global TEC for a storm that began at approximately 14 UT on December 14, 2006 with the arrival at earth of an interplanetary shock. (The color scale units are 1016 electrons/m2. GPS results are unavailable in white areas of the map.) The model successfully captured both the temporal and spatial variations in ionospheric ionization, and also agrees well with the measured magnitudes.



Comparison of modeled and measured total electron content in the ionosphere during a large geomagnetic storm. The large area of enhanced electron content over North America is common during large storms and can lead to disruptions innavigation and communication systems.Credit: Jeffrey Hughes

Results from the Center for Integrated Space Weather Modeling (CISM) - COUPLED MODELING OF THE EQUATORIAL IONOSPHERE DURING GEOMAGNETIC STORMS

Highlight ID: 19300, Version: AC/GPA

Physical interactions between the magnetosphere and the ionosphere-thermosphere affect processes in both regions during magnetic storms. CISM's Coupled Magnetosphere-Ionosphere-Thermosphere (CMIT) model is an important step in understanding, and ultimately predicting, the coupled system behavior. The new version of CMIT introduces the NCAR TIEGCM model of the ionosphere-thermosphere, providing the capability to study global ionospheric disturbances during geomagnetic storms. Figure shows modeled equatorial vertical ion drifts (red line) compared to measurements by the Jicamarca radar (blue crosses). April 2, 2004, was a quiet day, followed by a significant geomagnetic storm that began at 2 UT on April 3. In the top panel, the stand-alone TIEGCM model captures many of the overall trends, but does not successfully represent the dynamic structure that is caused by interactions with the magnetosphere. The coupled CMIT model, in the bottom panel, provides a much better characterization of the dynamics of the coupled system. Temporal variations in the model are consistent with the data, but somewhat overestimated, due to the lack of a full characterization of region-2 shielding currents. This work illustrates the importance and promise of using coupled models to represent the complex physics of space weather. CISM is a NSF Science technology Center overseen by the Division of Atmospheric Sciences in coordination with the Office of Integrative Activities.

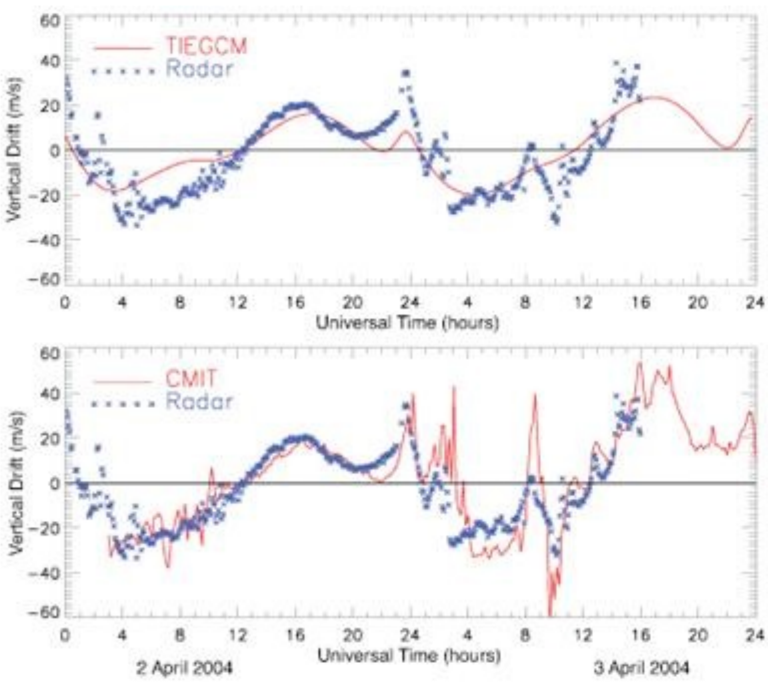


Figure CISM Modeled time series of equatorial ion drifts, compared to ground based radar measurements
Credit: Jeffrey Hughes

Results from the Center for Integrated Space Weather Modeling (CISM) - COUPLED MODEL ANALYSIS OF IONOSPHERIC STORM
Highlight ID: 19309, Version: AC/GPA
Ionospheric storms are extreme space weather phenomena involving complex interactions of several processes within the earth's magnetosphere-ionosphere-thermosphere system. CISM scientists have used the Coupled Magnetosphere-Ionosphere-Thermosphere model (CMIT 2.0) to simulate in detail the initial phase of

a December 2006 geomagnetic storm, when the geospace system was strongly driven by an interplanetary shock. After validating the fidelity of the simulation, the model was used to investigate the causes of the ionospheric responses and to quantify the relative contributions of different physical processes. Figure shows differences relative to quiet-time values for several quantities at one location (35 deg N, 75 deg W) over 10 hours, beginning approximately 1 hour before shock arrival. Differences in electron density and the rate of change in oxygen ion density are shown in the top and bottom panels. The production-loss and transport terms contributing to the ion density variation are separately shown in the middle four panels. Such "term analyzes" are a powerful tool, enabled by sophisticated coupled models such as CMIT, for investigating the behavior of the complex space weather system. For example, in this case it was found that electric field changes are the dominant factor in the initial-phase storm effects in the American sector, although neutral winds and composition changes also contribute.

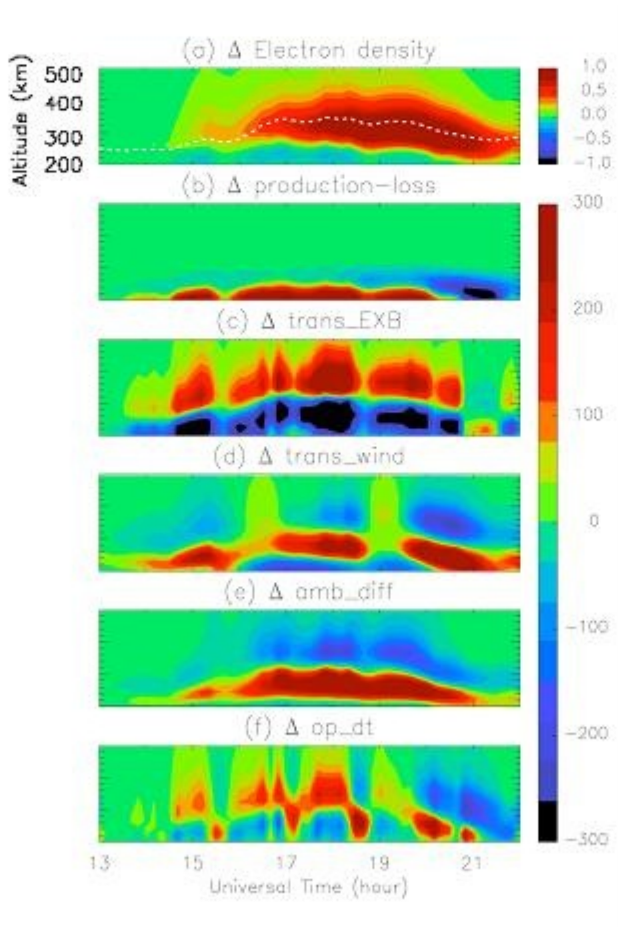


Figure (1) a time series showing events before and during a space weather event impacting the ionosphere.
Credit: Jeffrey Hughes

Space Weather Model Selected for NOAA Operational Forecasting

Highlight ID: 21187, Version: AC/GPA

As part of its Knowledge Transfer activities, the Center for Integrated Space Weather Modeling (CISM) has been working closely with NOAA's Space Weather Prediction Center (SWPC) to assess the potential of the WSA-ENLIL model for solar wind forecasting. This work has included daily forecast runs of the model at SWPC, model assessment and feedback by SWPC forecasters, and iterative development of model capabilities and prototype forecast visualizations. In addition to forecasting characteristics of the continuous "ambient" solar wind, ENLIL incorporates the capability to model many aspects of the solar wind transients that arise from solar coronal mass ejections (CME), events that can trigger severe space weather effects. These CME forecasts use coronagraph observations of a CME as it leaves the sun to initiate a "cone model" representation within the numerical model that then propagates through the ambient solar wind to earth's orbit and beyond, providing a warning time in the range of 1-3 days. Because of the importance of such forecasts to space weather consumers, SWPC has recently selected this model for transition into formal forecast operations; it will be run on supercomputers at NOAA's National Centers for Environmental Prediction (NCEP). CISM is supporting the transition in partnership with SWPC, NCEP, Air Force Research Laboratory, the multi-agency Community Coordinated Modeling Center, and Air Force Weather Agency.

Investigations of the role of the ionosphere in sudden warmings in the Stratosphere

Highlight ID: 19148, Version: AC/GPA

Researchers have previously proposed that lower atmospheric processes may account for some ionospheric variability. With this in mind Goncharenko and colleagues from MIT Haystack Observatory and Jicamarca Radio Observatory studied an episode of sudden stratospheric warming, which occurred in January 2008, and compared results with temperature fluctuations in the ionosphere and thermosphere as recorded by a ground-based radar. Goncharenko found that at middle latitudes, ionospheric variations that could not be explained through the seasonal trends, solar flux, and geomagnetic activity, and were instead correlated with fluctuating temperatures in the stratosphere, demonstrating a previously unobserved link between the lower atmosphere and the ionosphere. As sudden stratospheric warmings are a high-latitude event, the most unexpected changes observed during this warming episode were large semidiurnal variations in low-latitude plasma velocities, with upward plasma transport in the morning hours, followed by the downward transport in the afternoon hours. The electron density data from ground based GPS receivers revealed an enhancement of equatorial ionization anomaly in the morning and suppression in the late afternoon, as a result of this plasma motion. The observed control of the daytime equatorial anomaly has major practical space weather implications**.** These results have demonstrated that studies of space weather should consider ionospheric variability linked to stratospheric changes.

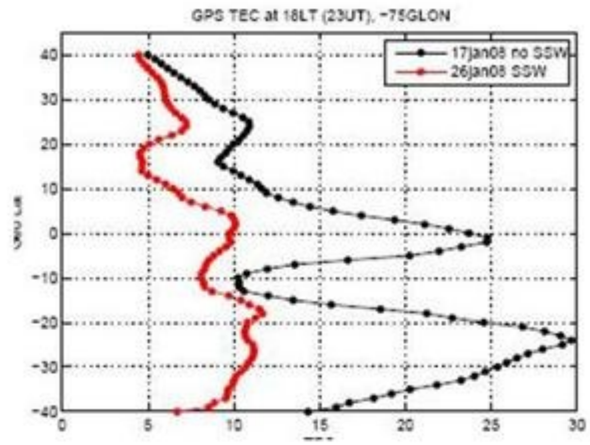


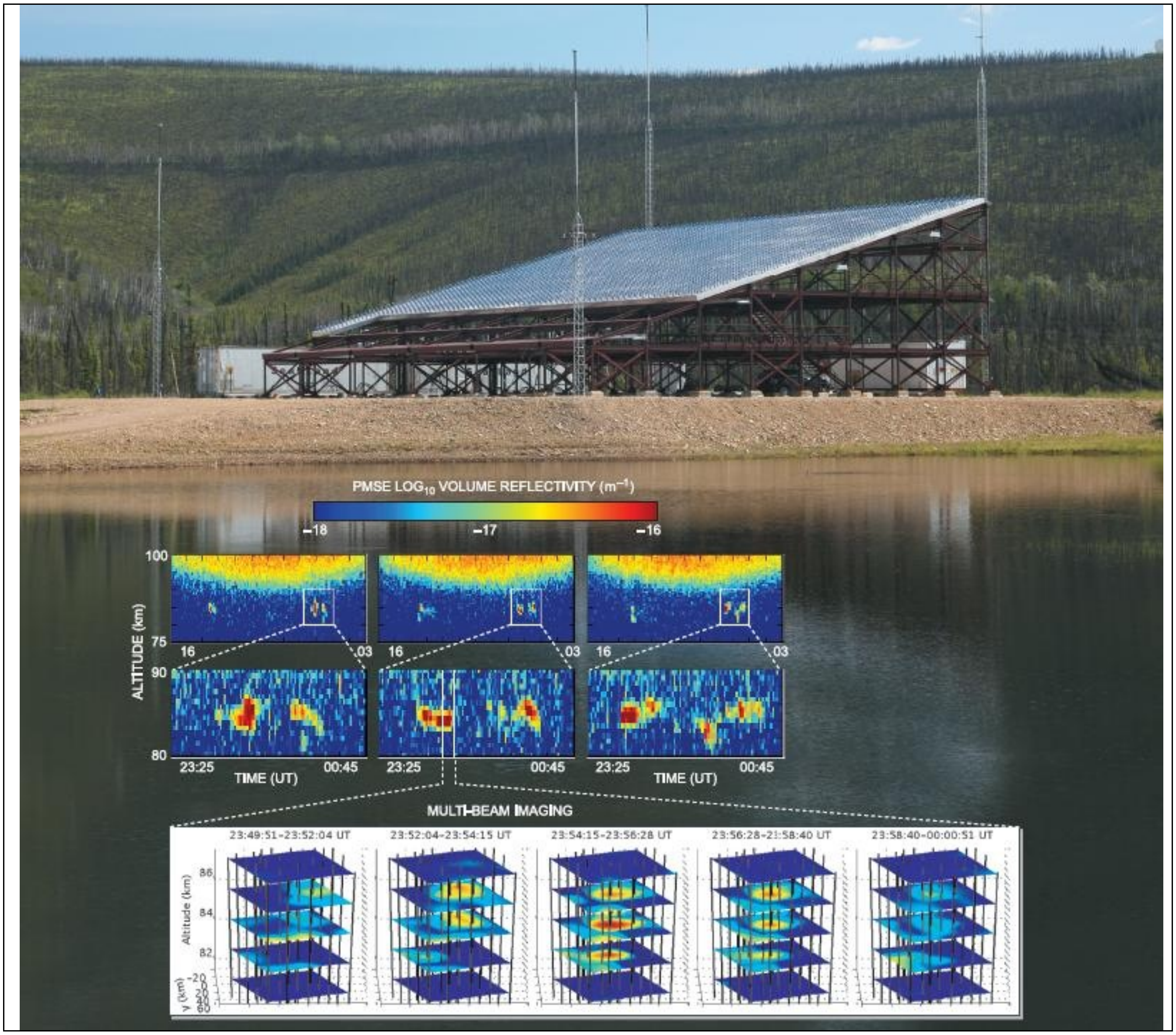
Figure (1)

Figure (1). Variation in mid-latitude ion temperature observed during stratospheric warming as compared to baseline data. A warming is observed in the lower thermosphere at ~120-140 km, accompanied by a 20-75K cooling above ~140 km. It is well established that stratospheric warming is accompanied by mesospheric cooling, but these observations show for the first time that areas of warming and cooling extend to altitudes of upper thermosphere (~300 km).
Credit: Larisa P Goncharenko

New Radar Observations from Poker Flat, Alaska

Highlight ID: 16637, Version: AC/GPA

The Poker Flat Incoherent Scatter Radar (PFISR) is a 450 MHz phased-array radar with solid-state components that allow for remote operation and versatile pulse-to-pulse beam steering. The ability to probe multiple volumes essentially simultaneously allows for the imaging of ionospheric structures such as Polar Mesosphere Summer Echoes (PMSE), which are associated with ice particles and Noctilucent Clouds (NLCs) that form in the mesopause region, the coldest place on Earth. PFISR represents a new era in incoherent scatter observations of the ionosphere. Its modular design will allow the radar to be disassembled and moved to other locations as scientific requirements demand. These early observations demonstrate the high sensitivity and excellent spatial and temporal resolution. The radar is being operated routinely throughout the International Polar Year to provide a synoptic data base important for studies of climate change and space weather.

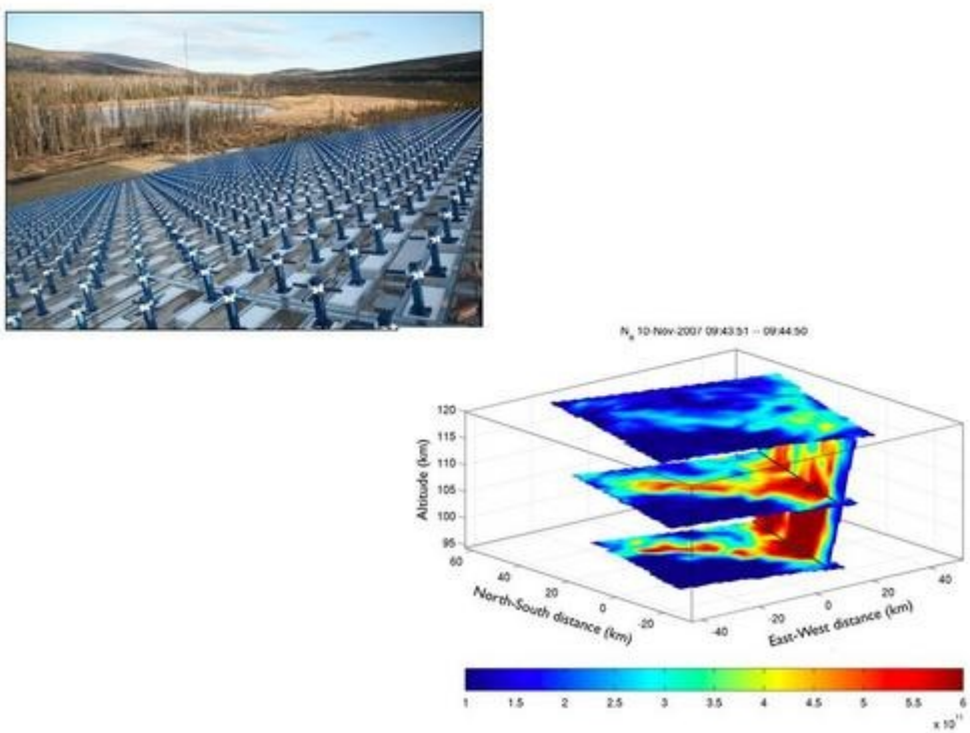


The Poker Flat Incoherent Scatter Radar. Insets show radar backscatter from Polar Mesospheric Summer Echoes between 80 and 90 km altitude. The middle row focuses in on a region of interested. In the bottom, 25 beams (black lines) have been used to create the first three-dimensional images of these structures in the middle atmosphere.
Credit: Reproduced by permission of American Geophysical Union

Three-dimensional imaging of the auroral ionosphere

Highlight ID: 18704, Version: AC/GPA

Incoherent scatter radar (ISR) is a powerful tool for studying the ionosphere and its interactions with the space environment. Prior to 2006, scanning the sky with an ISR meant mechanically steering a 30-ton dish antenna. The Poker Flat ISR (or PFISR) is the first ISR employing an electronically steerable array (ESA). This modality enables, for the first time, direct three-dimensional imaging of the Earth's plasma environment, and a new observing paradigm for space plasma research. The PFISR beam is steered by carefully controlling the signals delivered to each of the 4096 antenna elements (in figure). This rapid steering capability means that data is acquired, in essence, simultaneously from a set of predefined look-directions, analogous to the way images are acquired with a digital camera. A major difference with photography, however, is that radars also acquire information along the direction of each beam. Thus, PFISR can be used to construct three-dimensional (or volumetric) images of the ionospheric plasma at rapid cadence. The example in the figure shows plasma density at three horizontal cuts (100, 110, and 120 km) through the imaged volume, along with a single vertical cut as a back pane. The colors depict structure in plasma density caused by the aurora.

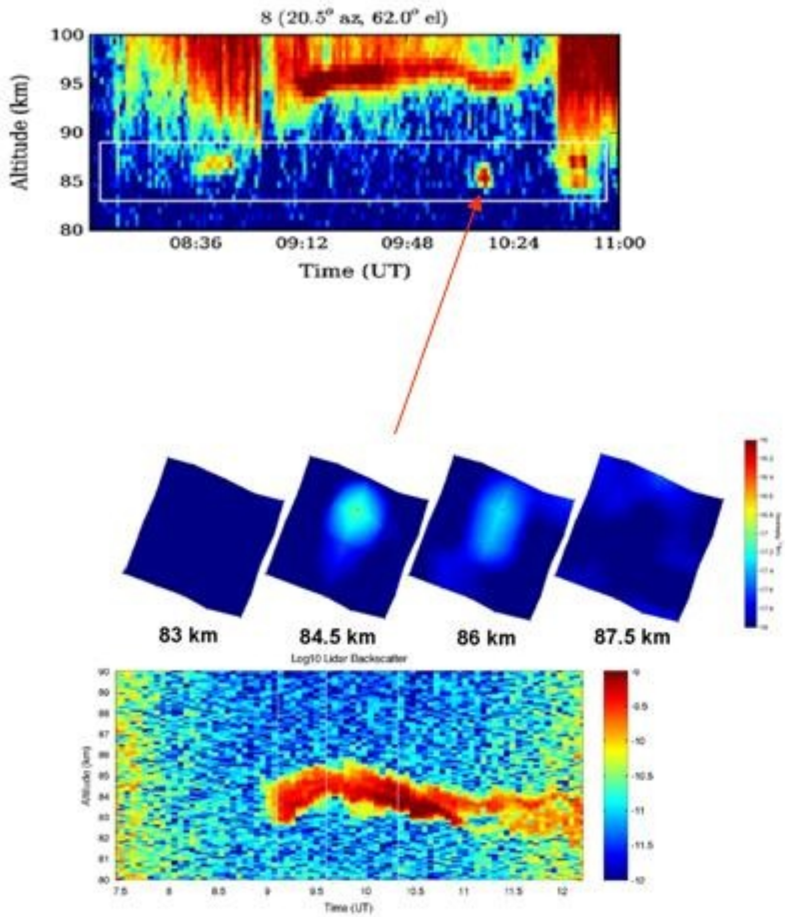


Top: PFISR antenna viewed from the top corner. Bottom: Ionospheric plasma density over the radar at three heights along the north-south and east-west directions.
Credit: J. Semeter

Multi-Instrument Measurements of Polar Mesospheric Clouds

Highlight ID: 19163, Version: AC/GPA

Novel coincident radar, lidar and imaging measurements of dynamical structures in Polar Mesosphere Summer Echoes (PMSE) and Noctilucent Clouds (NLC) were made on 10-11 August, 2007 in coordination with the NASA AIM satellite. Common volume mesospheric data were obtained over central Alaska using the new NSF funded Poker Flat Incoherent Scatter Radar (PFISR), combined with measurements from a co-located Rayleigh lidar and digital imaging from two nearby ground stations. The coincident measurements enabled the first detailed investigation of the horizontal and vertical structures of NLC and PMSE. On this particular study day, a well developed NLC was measured within the radar volume from ~9:00 UT until dawn. Strong but intermittent PMSE were detected by the PFISR instrument, with distinct patchy structures that exhibited a similar southward motion as the NLC; see Figure. Detailed comparison of the 3-D PMSE structures and the NLC lidar and 2-D image data have revealed striking similarities when account is taken of the NLC layer altitude. Later measurements indicated that strong wind shears associated with Kelvin-Helmholtz instabilities (NLC billows) played a key role in the development of a neutral turbulence layer that resulted in the intermittent PMSE detected at 450 MHz.



First comparison of 2-D structure in NLC and a
height localized PMSE structure within the PFISR field of view.
Credit: Mike Taylor

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The program would benefit from an articulated strategic plan that would cover both the science objectives and priorities and the facility investment plan. In addition, the programs would benefit from the establishment of some metrics for success. This may become more important as time goes on as budget pressures are likely to increase and it may become imperative to be able to defend the efficacy of the various elements of the programs.

The role of the science staff at the major radar facilities needs to be better defined. The scientists employed at the facilities play an important role in the community overall, but their direct relationship to the instrument that they are supporting or to the broader user community is not clear in all cases. The justification for the staff positions at each of the facilities should be addressed specifically, as well as the broader justification for this type of arrangement.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The program is extremely successful and productive.

The Cubesat initiative represents an important new direction for the Geospace Facilities. The proposal submissions during the first few years of the program indicate a significant community interest and the nature of the proposed missions suggest a significant potential for new science. The program is offering the opportunity to involve new students in geospace programs and to develop an ongoing source of new scientists for the field.

The AMISR system was developed with the goal of providing a major re-deployable radar instrument for the field. The PFISR radar has now been operating at Poker Flat since 2007, and it appears imminent that the first re-deployment of that instrument will occur sometime within the next few years.

The Section should consider developing two new resources:
A strategic plan at the program level i.e. one for UAF, STR, AER, etc
We encourage the section to establish a series of campaign opportunities to focus facilities, resources, and attention on particular critical problems. Many of the difficult problems in the field require multiple instruments to be focused on the problem at the same time. Such campaigns have provided great benefit and increased the visibility of the program in the past and should be facilitated in the future.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

A critical concern in this program, as well as in many others, is the need for students to repopulate the field. Students are attracted to fields that are addressing important, relevant, challenging questions. However, that is not alone sufficient: there must be a sound future for employment within that field. The future health of Geospace Facilities specifically requires scientists and technical staff with a strong interest and training in ionospheric physics. Developing student involvement in this type of research should be an issue addressed by the agency.

C.4. Please provide comments on any other issues the COV feels are relevant.

The COV finds that the UAF review process and programs were carried out to the highest standards and was both consistent, resilient and innovative.
Geospace Facilities manages a broad portfolio of instruments. Some are state-of-the-art and will remain useful to the community for some time in the future. Other instruments are aging and may be providing data that is less useful. There should be a clear plan for assessing the usefulness of the various instruments and a plan for replacing or upgrading those facilities with more limited utility.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The strategic plans that were provided to the committee were helpful. In this case, they were provided in response to comments by and questions from some of the committee members. Since the strategic plan seems to be essential to many of the questions related to the future of the section, we suggest that such a plan should be part of the documentation made available to the committee prior to the start of the meeting. See also comment in part C.2.

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